

Exhibit A



US011667417B2

(12) **United States Patent**
Finzo et al.

(10) **Patent No.:** **US 11,667,417 B2**
(45) **Date of Patent:** **Jun. 6, 2023**

(54) **STRAPPING DEVICE HAVING A
PIVOTABLE ROCKER**

(71) Applicant: **Signode Industrial Group LLC**,
Tampa, FL (US)

(72) Inventors: **Flavio Finzo**, Würenlos (CH); **Mirco
Neeser**, Ehrendingen (CH); **Dimitrios
Takidis**, Dübendorf (CH)

(73) Assignee: **Signode Industrial Group LLC**,
Tampa, FL (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/149,827**

(22) Filed: **Jan. 4, 2023**

(65) **Prior Publication Data**
US 2023/0145839 A1 May 11, 2023

Related U.S. Application Data

(60) Continuation of application No. 17/653,581, filed on
Mar. 4, 2022, now Pat. No. 11,560,245, which is a
(Continued)

Foreign Application Priority Data

Sep. 24, 2012 (CH) 1723/12
Sep. 24, 2012 (CH) 1724/12

(51) **Int. Cl.**
B65B 13/22 (2006.01)
B65B 13/32 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **B65B 13/22** (2013.01); **B65B 13/02**
(2013.01); **B65B 13/025** (2013.01);
(Continued)

(58) Field of Classification Search

CPC B65B 13/02; B65B 13/025; B65B 13/18;
B65B 13/187; B65B 13/22; B65B 13/32;
B65B 13/322
See application file for complete search history.

(56) References Cited

U.S. PATENT DOCUMENTS

3,206,167 A 9/1965 Armington
3,284,049 A 11/1966 Haraden
(Continued)

FOREIGN PATENT DOCUMENTS

CA 2432353 A1 12/2003
CH 705745 A2 5/2013
(Continued)

OTHER PUBLICATIONS

“CB130 Operating Instructions—Hand Tool”, Cyklop, available
before the priority date of the present application.
(Continued)

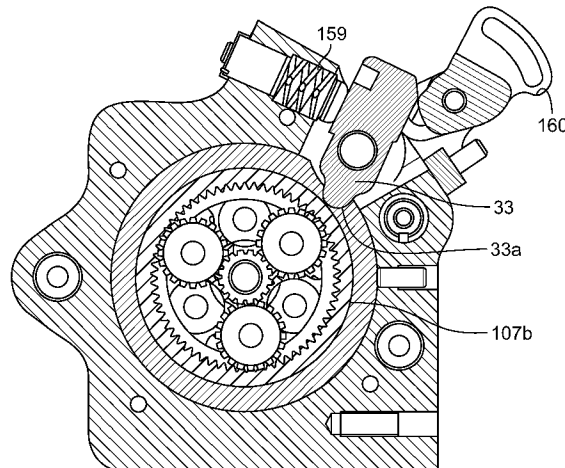
Primary Examiner — Jimmy T Nguyen

(74) *Attorney, Agent, or Firm* — Neal, Gerber &
Eisenberg LLP

(57) ABSTRACT

Various embodiments of the present disclosure provide a mobile strapping device for strapping packaged products using a loop of wrapping strap. The strapping device includes a tensioning device for applying tension to the strap and a connecting device for connecting two overlapping portions of the strap. The tensioning device includes a rotatable tensioning wheel and a tensioning plate. The tensioning wheel is supported by a rocker that is pivotable to change a distance separating the tensioning wheel and the tensioning plate. The mobile strapping device includes a motor that is operably connectable to the rocker or the tensioning wheel such that the motor causes pivoting of the rocker or rotation of the tensioning wheel when operating in a first direction of rotation. In various embodiments, gear-

(Continued)



US 11,667,417 B2

Page 2

ing, including a plurality of planetary gear sets, is used to operatively connect the motor to the rocker and the tensioning wheel.

19 Claims, 10 Drawing Sheets

Related U.S. Application Data

continuation of application No. 16/448,167, filed on Jun. 21, 2019, now Pat. No. 11,267,596, which is a continuation of application No. 15/910,346, filed on Mar. 2, 2018, now Pat. No. 10,370,132, which is a division of application No. 14/430,163, filed as application No. PCT/IB2013/002116 on Sep. 24, 2013, now Pat. No. 9,938,029.

- (51) **Int. Cl.**
B65B 13/18 (2006.01)
B65B 13/02 (2006.01)
- (52) **U.S. Cl.**
 CPC **B65B 13/187** (2013.01); **B65B 13/32** (2013.01); **B65B 13/322** (2013.01)

(56) References Cited

U.S. PATENT DOCUMENTS

3,360,017 A 12/1967 Vilcins
 3,367,374 A 2/1968 Meier et al.
 3,442,733 A 5/1969 Vilcins
 3,654,033 A 4/1972 Angarola et al.
 3,844,317 A 10/1974 Angarola et al.
 4,011,807 A 3/1977 Kobiella
 4,015,643 A 4/1977 Cheung
 4,020,879 A 5/1977 Billett et al.
 4,050,372 A 9/1977 Kobiella
 4,161,910 A 7/1979 Leslie et al.
 4,239,096 A 12/1980 Smilgys et al.
 4,240,865 A 12/1980 Kyts
 4,313,779 A 2/1982 Nix
 4,450,032 A 5/1984 Wehr
 4,535,730 A 8/1985 Allen
 4,572,064 A 2/1986 Burton
 4,607,709 A 8/1986 Walser
 4,707,390 A 11/1987 Cheung
 4,776,905 A 10/1988 Cheung et al.
 5,105,130 A 4/1992 Barker et al.
 5,133,532 A 7/1992 Figiel et al.
 5,146,847 A 9/1992 Lyon et al.
 5,155,982 A 10/1992 Boek et al.
 5,159,218 A 10/1992 Murry et al.
 5,165,532 A 11/1992 Pipich et al.
 5,379,576 A 1/1995 Koyama
 5,509,594 A 4/1996 Maggioni
 5,516,022 A 5/1996 Annis
 5,632,851 A 5/1997 Young
 5,653,095 A 8/1997 Stamm
 5,689,943 A 11/1997 Wehr
 5,690,023 A 11/1997 Stamm et al.
 5,798,596 A 8/1998 Lordo
 5,809,873 A 9/1998 Chak et al.
 5,831,404 A 11/1998 Ishii
 5,853,524 A 12/1998 Nix
 5,881,855 A 3/1999 Putney et al.
 5,916,108 A 6/1999 Drietz et al.
 5,947,166 A 9/1999 Doyle et al.
 5,954,899 A 9/1999 Figiel et al.
 6,003,578 A 12/1999 Chang
 6,073,664 A 6/2000 Angarola
 6,079,457 A 6/2000 Crittenden
 6,109,325 A 8/2000 Chang
 6,173,747 B1 1/2001 Angarola et al.

6,260,337 B1 7/2001 Cheung
 6,308,745 B1 10/2001 Angarola et al.
 6,308,760 B1 10/2001 Finzo et al.
 6,328,087 B1 12/2001 Finzo et al.
 6,332,306 B1 12/2001 Finzo et al.
 6,338,375 B1 1/2002 Harada
 6,345,658 B1 2/2002 Shida et al.
 6,405,766 B1 6/2002 Benjey
 6,415,712 B1 7/2002 Helland et al.
 6,422,272 B1 7/2002 Crittenden
 6,516,715 B1 2/2003 Reiche
 6,533,013 B1 3/2003 Nix
 6,554,030 B2 4/2003 Cheung et al.
 6,568,158 B2 5/2003 Shibazaki et al.
 6,578,337 B2 6/2003 Scholl et al.
 6,584,891 B1 7/2003 Smith et al.
 6,606,766 B2 8/2003 Ko
 6,640,838 B2 11/2003 Finzo
 6,644,713 B2 11/2003 Del et al.
 6,698,460 B2 3/2004 Marsche
 6,715,375 B2 4/2004 Nestler
 6,729,357 B2 5/2004 Marsche
 6,732,638 B1 5/2004 Rometty et al.
 6,772,798 B2 8/2004 Cheung
 6,817,159 B2 11/2004 Sakaki et al.
 6,907,717 B2 6/2005 Nix
 6,911,799 B2 6/2005 Jensen
 6,918,235 B2 7/2005 Nix
 6,957,678 B2 10/2005 Scholl et al.
 7,011,000 B2 3/2006 Kushida et al.
 7,073,431 B1 7/2006 Chen
 7,128,099 B2 10/2006 Finzo
 7,155,885 B1 1/2007 Nasiatka et al.
 7,157,882 B2 1/2007 Johnson et al.
 7,204,187 B2 4/2007 Zeimetz et al.
 7,236,243 B2 6/2007 Beecroft et al.
 7,249,862 B2 7/2007 Shirane
 7,312,609 B2 12/2007 Schmollngruber et al.
 7,350,543 B2 4/2008 Crittenden
 7,455,080 B2 11/2008 Crittenden et al.
 7,456,608 B2 11/2008 Kageler et al.
 7,497,068 B2 3/2009 Nasiatka et al.
 7,556,129 B2 7/2009 Nix
 7,562,620 B1 7/2009 Nasiatka et al.
 7,703,330 B2 4/2010 Miyazaki et al.
 D629,321 S 12/2010 Neeser et al.
 7,857,560 B2 12/2010 Leggett et al.
 7,948,336 B2 5/2011 Park
 D651,498 S 1/2012 Neeser et al.
 D653,923 S 2/2012 Neeser et al.
 8,198,839 B2 6/2012 Katou et al.
 8,281,711 B2 10/2012 Haberstroh et al.
 8,287,672 B2 10/2012 Neeser et al.
 8,378,600 B2 2/2013 Katou et al.
 8,567,310 B2 10/2013 Yi
 8,967,217 B2 3/2015 Gardner et al.
 9,174,752 B2 11/2015 Neeser et al.
 9,193,486 B2 11/2015 Neeser et al.
 9,233,457 B2 1/2016 Wanek et al.
 9,248,553 B2 2/2016 Schurder et al.
 9,254,932 B2 2/2016 Neeser et al.
 9,272,799 B2 3/2016 Figiel et al.
 9,284,080 B2 3/2016 Neeser et al.
 9,315,283 B2 4/2016 Neeser et al.
 9,346,572 B2 5/2016 Leppert
 9,387,573 B2 7/2016 Pearson
 9,403,609 B2 8/2016 Bonifazi et al.
 9,468,968 B2 10/2016 Figiel et al.
 9,487,314 B2 11/2016 Finzo
 9,586,708 B2 3/2017 Finzo
 9,932,135 B2 4/2018 Finzo et al.
 9,938,029 B2 4/2018 Finzo et al.
 9,994,341 B2 6/2018 Amacker et al.
 10,058,989 B2 8/2018 Chellew
 10,370,132 B2 8/2019 Finzo et al.
 11,267,596 B2 * 3/2022 Finzo B65B 13/322
 11,560,245 B2 * 1/2023 Finzo B65B 13/02
 2002/0100146 A1 8/2002 Ko
 2002/0129717 A1 9/2002 Helland et al.

US 11,667,417 B2

Page 3

(56)

References Cited

U.S. PATENT DOCUMENTS

2002/0134811 A1 9/2002 Napier et al.
 2003/0131570 A1 7/2003 Scholl et al.
 2003/0145900 A1 8/2003 Jensen et al.
 2003/0221566 A1 12/2003 Apel et al.
 2003/0230058 A1 12/2003 Nix
 2004/0050188 A1 3/2004 Richards et al.
 2004/0206251 A1 10/2004 Nix
 2005/0279198 A1 12/2005 Kushida et al.
 2006/0108180 A1 5/2006 Grach et al.
 2006/0192527 A1 8/2006 Kageler et al.
 2008/0196911 A1 8/2008 Krapf et al.
 2008/0219745 A1 9/2008 Bungert et al.
 2009/0013656 A1 1/2009 Nasiatka et al.
 2009/0114308 A1 5/2009 Nelson et al.
 2011/0056391 A1 3/2011 Neeser et al.
 2011/0056392 A1 3/2011 Neeser et al.
 2011/0100233 A1 5/2011 Neeser et al.
 2011/0253480 A1 10/2011 Goodman et al.
 2012/0007748 A1 1/2012 Forgues et al.
 2012/0017780 A1 1/2012 Haberstroh et al.
 2012/0160364 A1 6/2012 Katou et al.
 2012/0210682 A1 8/2012 Gardner et al.
 2013/0092408 A1 4/2013 Oberheim
 2013/0186287 A1 7/2013 Vick et al.
 2014/0008090 A1 1/2014 Kokinelis et al.
 2014/0083311 A1 3/2014 Bonifazi et al.
 2014/0290179 A1 10/2014 Keller
 2014/0311363 A1 10/2014 Leppert
 2015/0033959 A1 2/2015 Finzo
 2015/0034206 A1 2/2015 Finzo
 2016/0046398 A1 2/2016 Neeser et al.
 2016/0107775 A1 4/2016 Amacker et al.
 2016/0159505 A1 6/2016 Widmer et al.

FOREIGN PATENT DOCUMENTS

CN 2266566 Y 11/1997
 CN 2346694 Y 11/1999
 CN 1253098 A 5/2000
 CN 1055426 C 8/2000
 CN 1297270 A 5/2001
 CN 1386675 A 12/2002
 CN 1386676 A 12/2002
 CN 1660675 A 8/2005
 CN 101164416 A 4/2008
 CN 100460284 C 2/2009
 CN 101422761 A 5/2009
 CN 101486329 A 7/2009
 CN 101585244 A 11/2009
 CN 201411059 Y 2/2010
 CN 101870367 A 10/2010
 CN 201957492 U 9/2011
 CN 202100012 U 1/2012
 CN 105358432 A 2/2016
 DE 1973947 U 11/1967
 DE 3525647 A1 1/1987
 DE 4014305 A1 11/1991
 DE 4204420 A1 8/1993
 DE 19751861 A1 1/1999
 DE 10026200 A1 11/2001
 DE 20321137.5 U1 1/2006
 DE 102005049130 A1 4/2007
 DE 102006007990 A1 8/2007
 DE 202011050797.1 U1 11/2011
 EP 0095643 A2 12/1983
 EP 0603868 A1 6/1994
 EP 0659525 A2 6/1995
 EP 0664256 A1 7/1995
 EP 0744343 A1 11/1996

EP 1177978 A1 2/2002
 EP 1413519 A1 4/2004
 GB 1161827 A 8/1969
 GB 2041869 A 9/1980
 GB 2098163 A 11/1982
 GB 2185229 A 7/1987
 GB 2185228 B 12/1987
 GB 2481724 A 1/2012
 JP S541238 B1 1/1979
 JP S5638220 A 4/1981
 JP 01006555 A 1/1989
 JP H07300108 A 11/1995
 JP H08258808 A 10/1996
 JP H09283103 A 10/1997
 JP 3054566 U 12/1998
 JP 3044132 B2 5/2000
 JP 2003231291 A 8/2003
 JP 2003534989 A 11/2003
 JP 2003348899 A 12/2003
 JP 2004018117 A 1/2004
 JP 2004108593 A 4/2004
 JP 2004241150 A 8/2004
 JP 2011518085 A 6/2011
 JP 2011518088 A 6/2011
 KR 100943256 B1 2/2010
 RU 1772784 C 10/1992
 RU 2161773 C2 1/2001
 RU 2355821 C1 5/2009
 TW 1276571 B 3/2007
 WO 0189929 A1 11/2001
 WO 2006048738 A1 5/2006
 WO 2009129633 A1 10/2009
 WO 2009129634 A1 10/2009
 WO 2009129636 A1 10/2009
 WO 2014072775 A1 5/2014

OTHER PUBLICATIONS

“Description of the Operating Sequence of the Cyklop CB 130 Tool”, The Cyklop CB 130 Tool was publicly available before the priority date of the present application.

“Docket Report”, in U.S. District Court for the District of Delaware, Case No. 1:22-cv-00519, *Signode Industrial Group LLC v. Polychem, LLC*, Aug. 26, 2022.

“International Search Report and Written Opinion”, for International Application No. PCT/IB2013/002116 (8 pages), dated Jun. 30, 2014.

“ORT-200 Manual Battery-hand Tool for Plastic Strapping”, Orgapack, available before the priority date of the present application.

“ORT-250 Manual Battery-operated Hand Tool for Plastic Strapping”, Orgapack, available before the priority date of the present application.

“Polychem, LLC’s Answer to Complaint for Patent Infringement, Affirmative Defenses and Counterclaims”, in U.S. District Court for the District of Delaware, Case No. 1:22-cv-00519, *Signode Industrial Group LLC v. Polychem, LLC*, Jun. 24, 2022.

“Signode Industrial Group LLC’s Complaint for Patent Infringement”, U.S. District Court for the District of Delaware, Case No. 1:22-cv-00519, *Signode Industrial Group LLC v. Polychem, LLC*, Apr. 22, 2022.

Bender, “Lithium Ion Technology: Shaping Power Tool”, Air Conditioning, Heating, and Refrigeration News, vol. 228, Issue 14, p. 18 (3 pages), Jul. 31, 2006.

“Chinese Office Action and Search Report”, Chinese Application No. 201380061441.6 (9 pages), Feb. 1, 2016.

Emandi, Ali, “Brushless DC Motor Drives”, Energy-Efficient Electrical Motors, 3rd ed., Para. 270-272, CRC Press & Marcel Dekker (3 pages), Aug. 1, 2004.

* cited by examiner

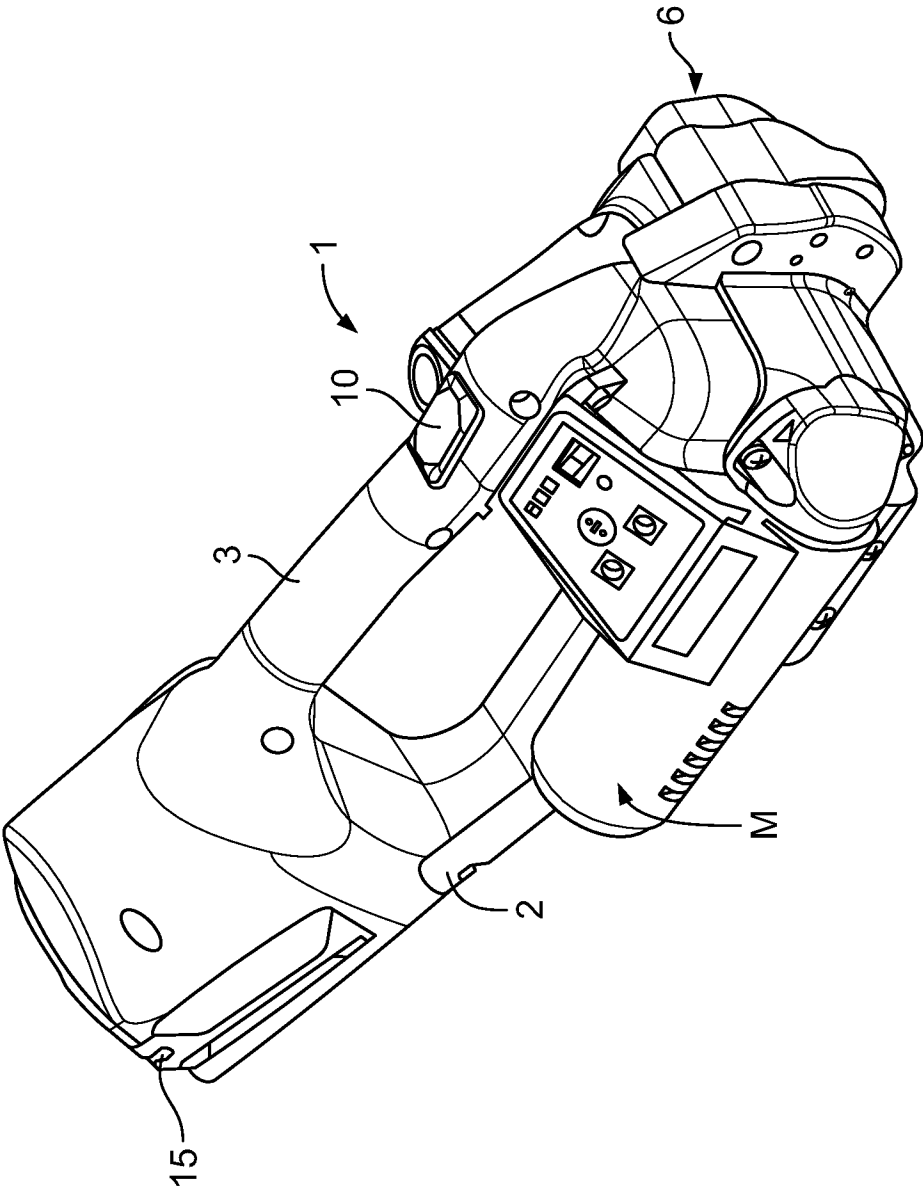


FIG. 1

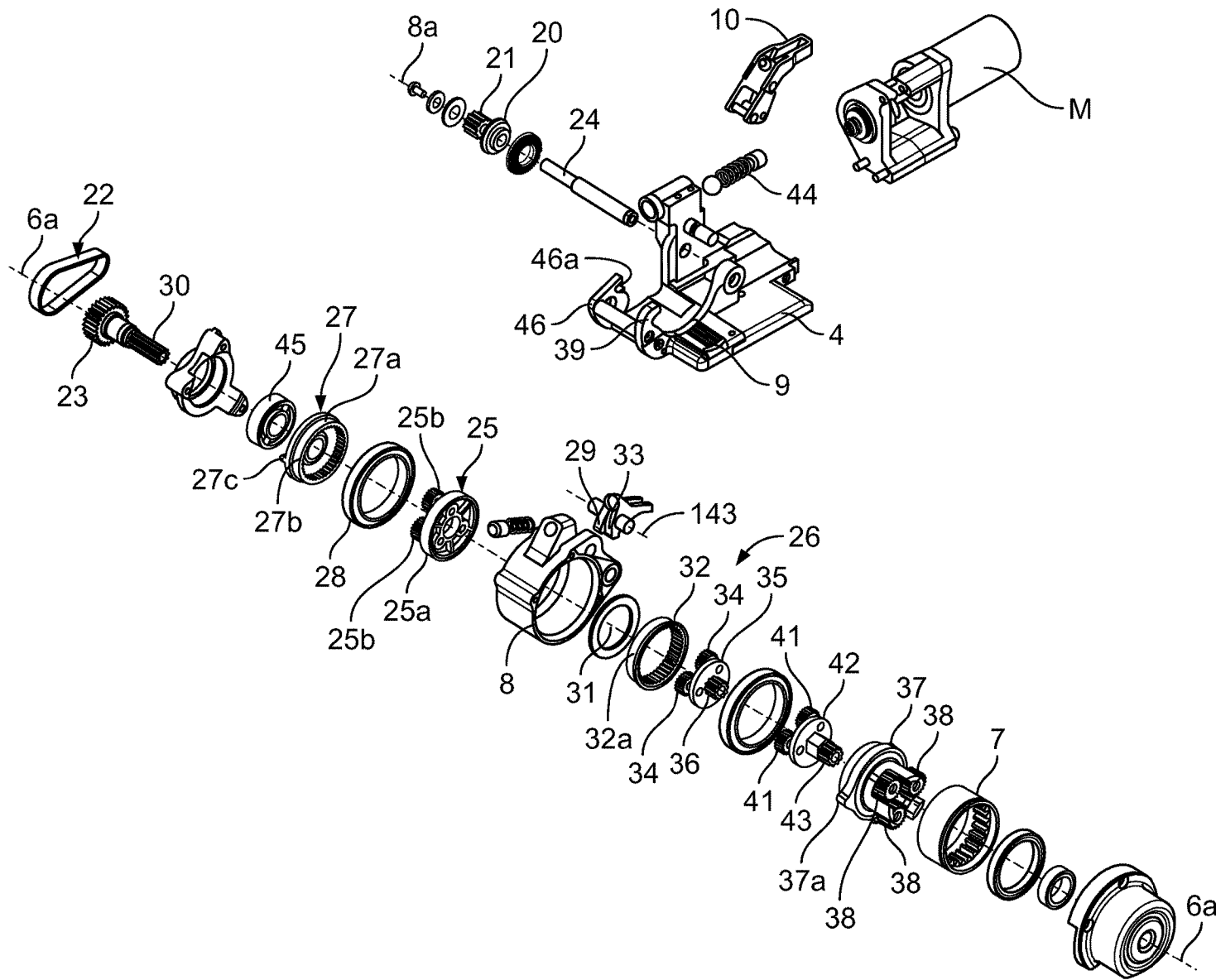


FIG. 2

U.S. Patent

Jun. 6, 2023

Sheet 3 of 10

US 11,667,417 B2

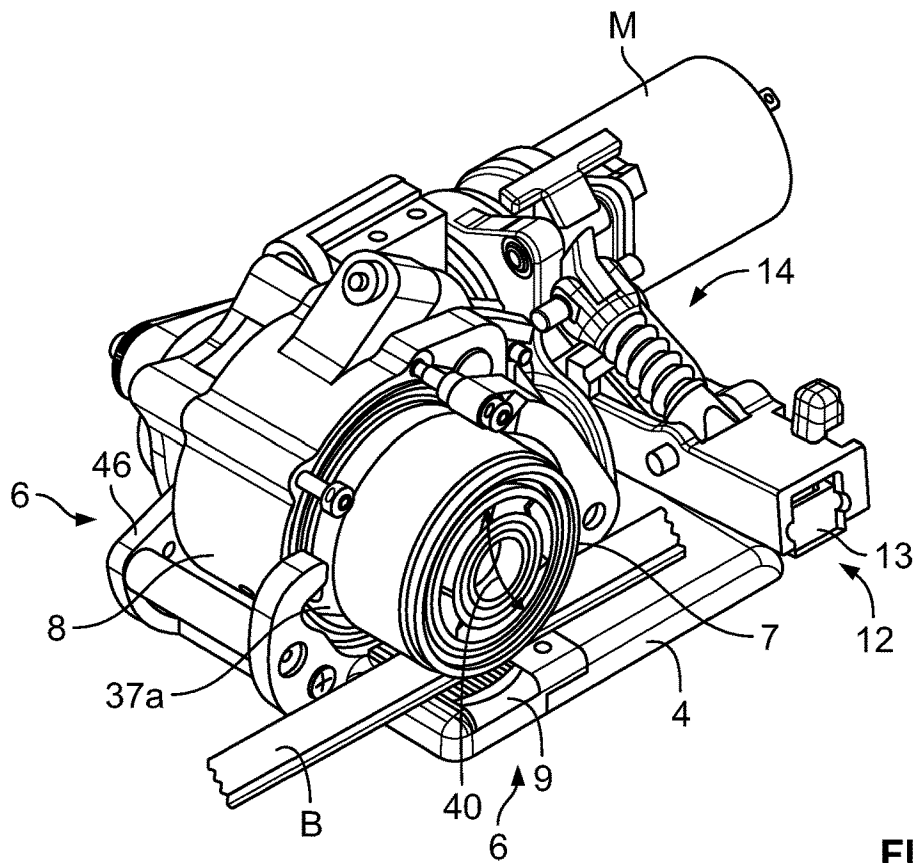


FIG. 3

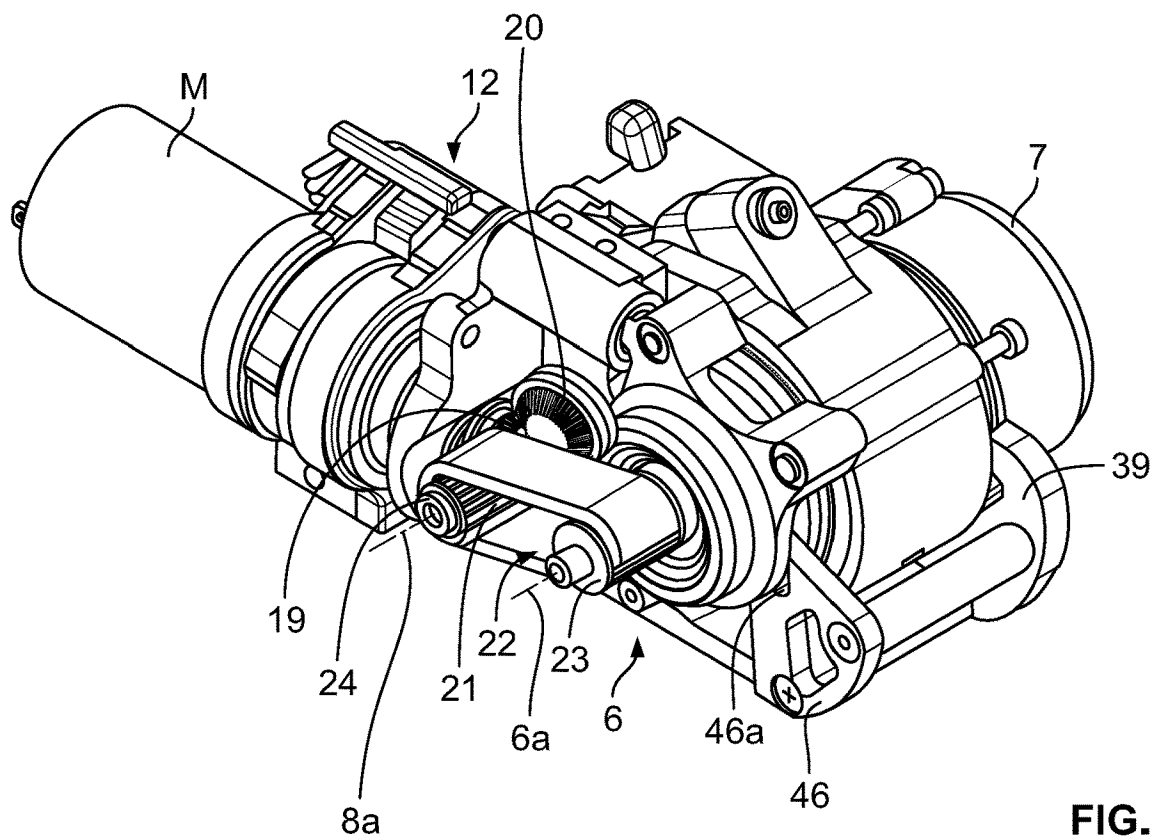


FIG. 4

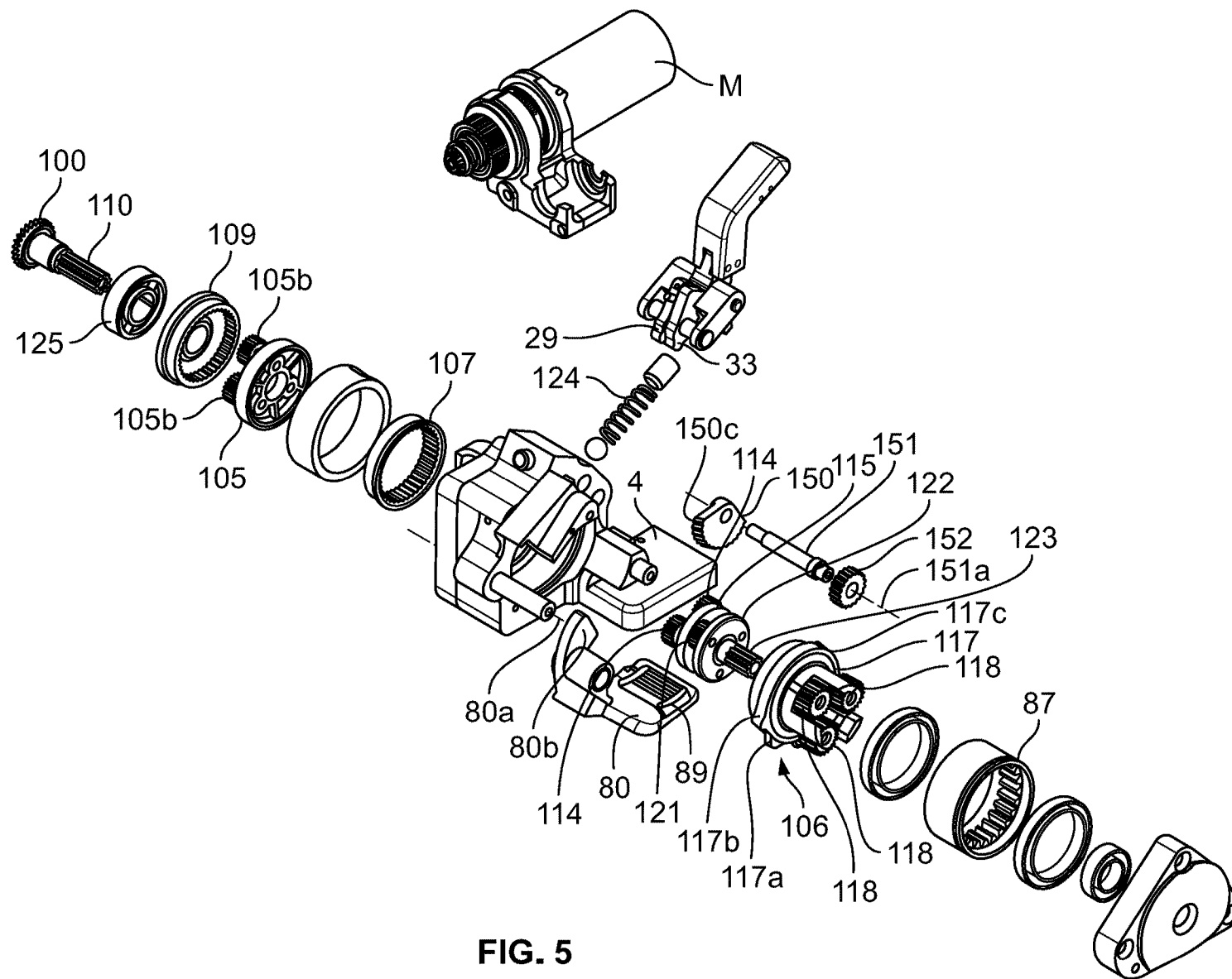
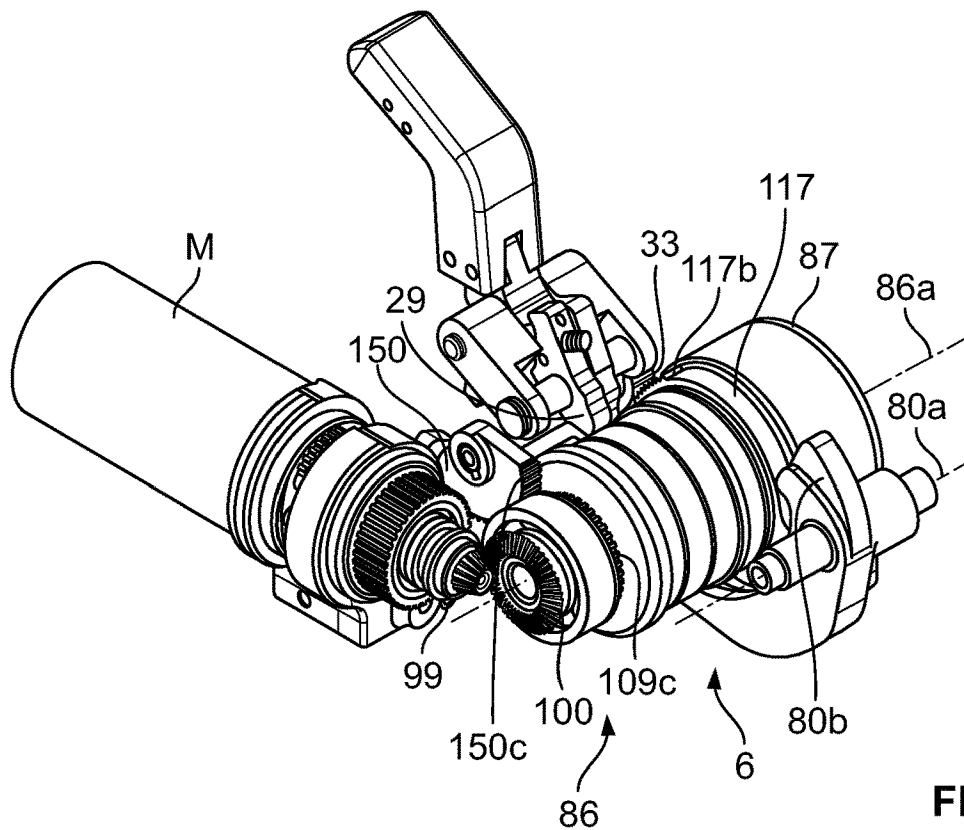
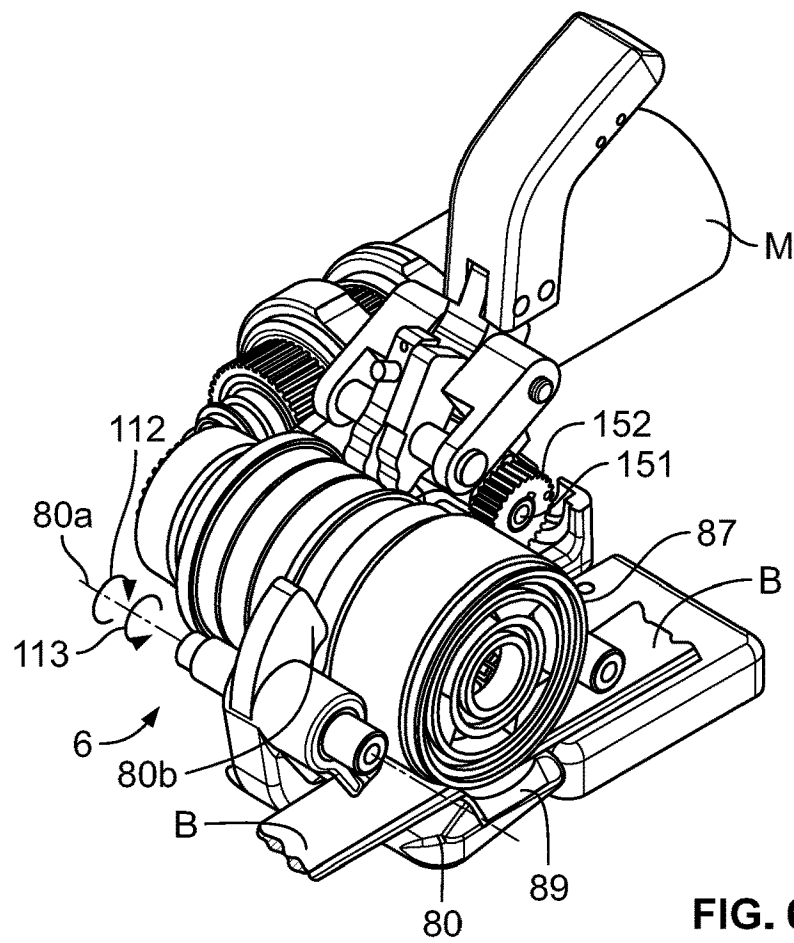


FIG. 5

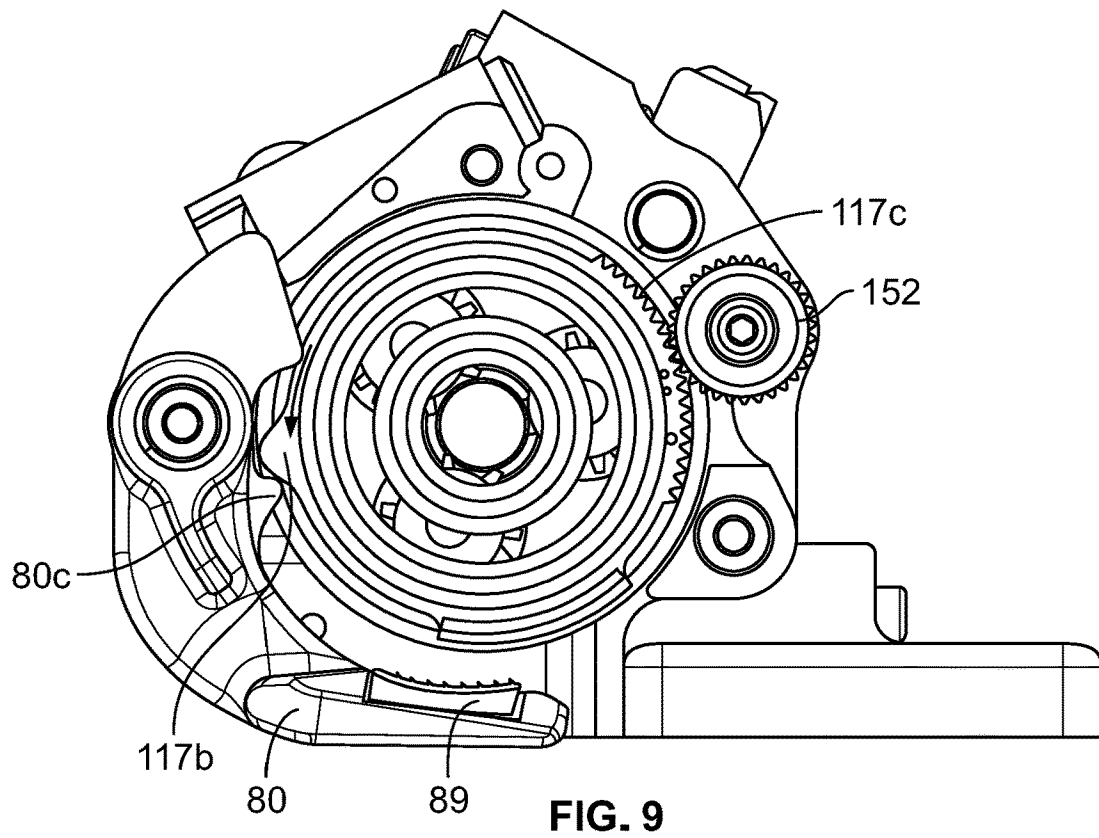
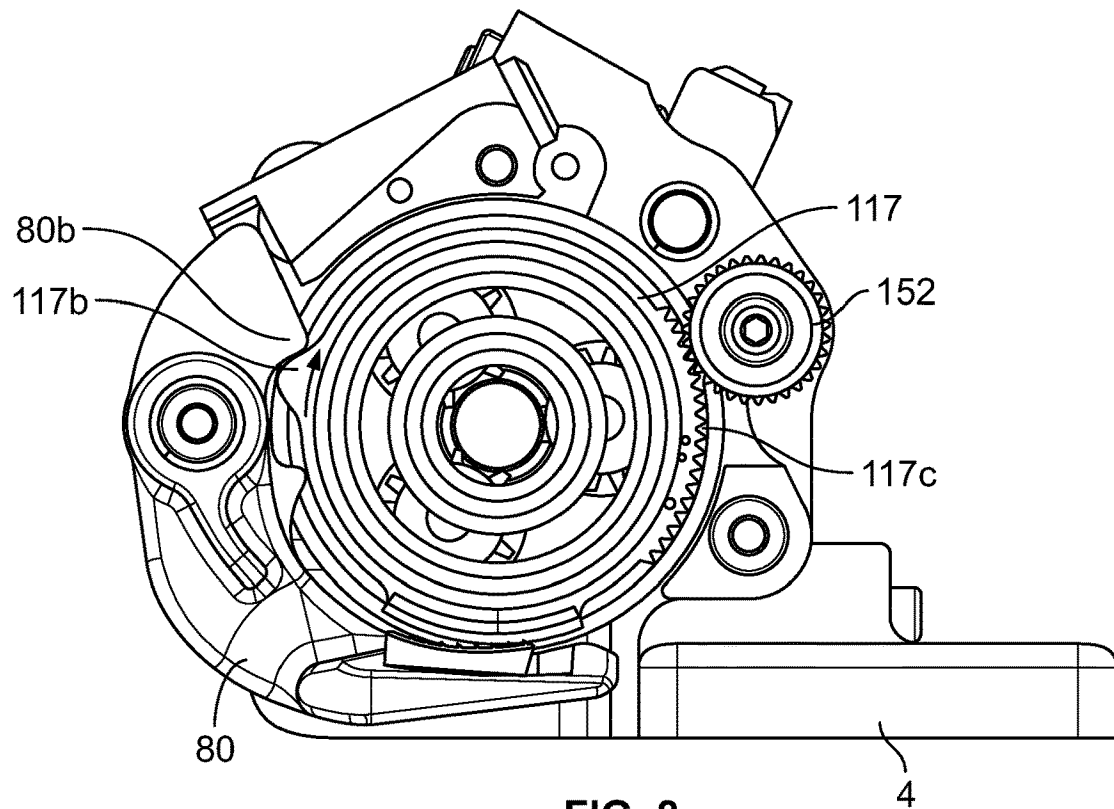


U.S. Patent

Jun. 6, 2023

Sheet 6 of 10

US 11,667,417 B2



U.S. Patent

Jun. 6, 2023

Sheet 7 of 10

US 11,667,417 B2

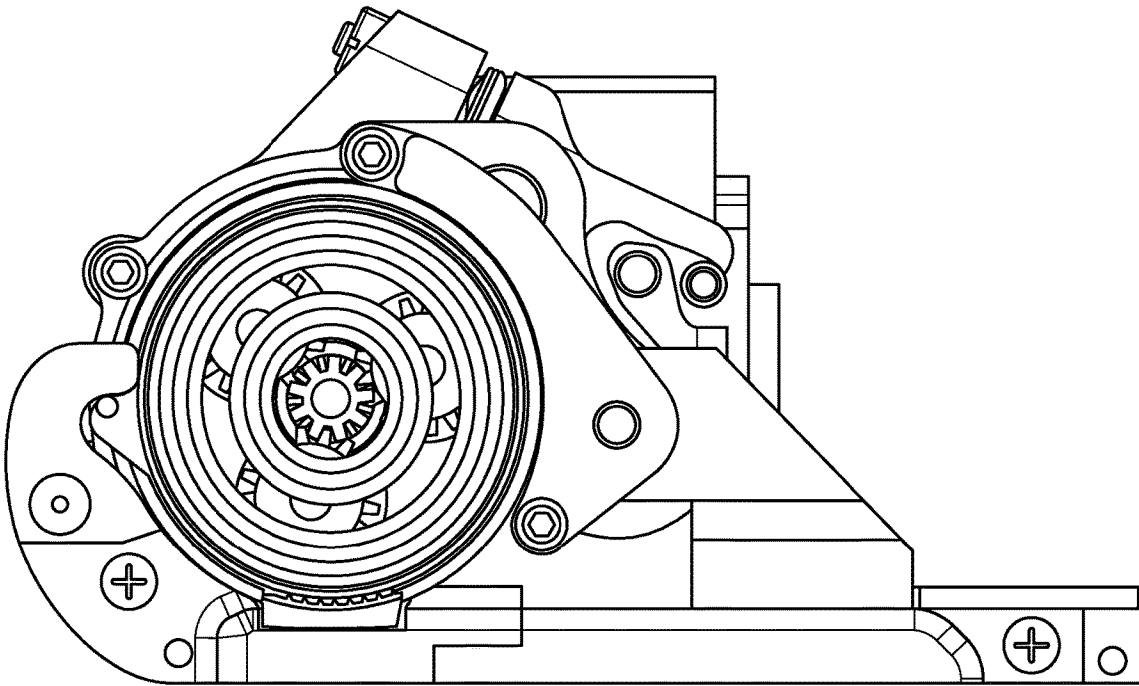


FIG. 10

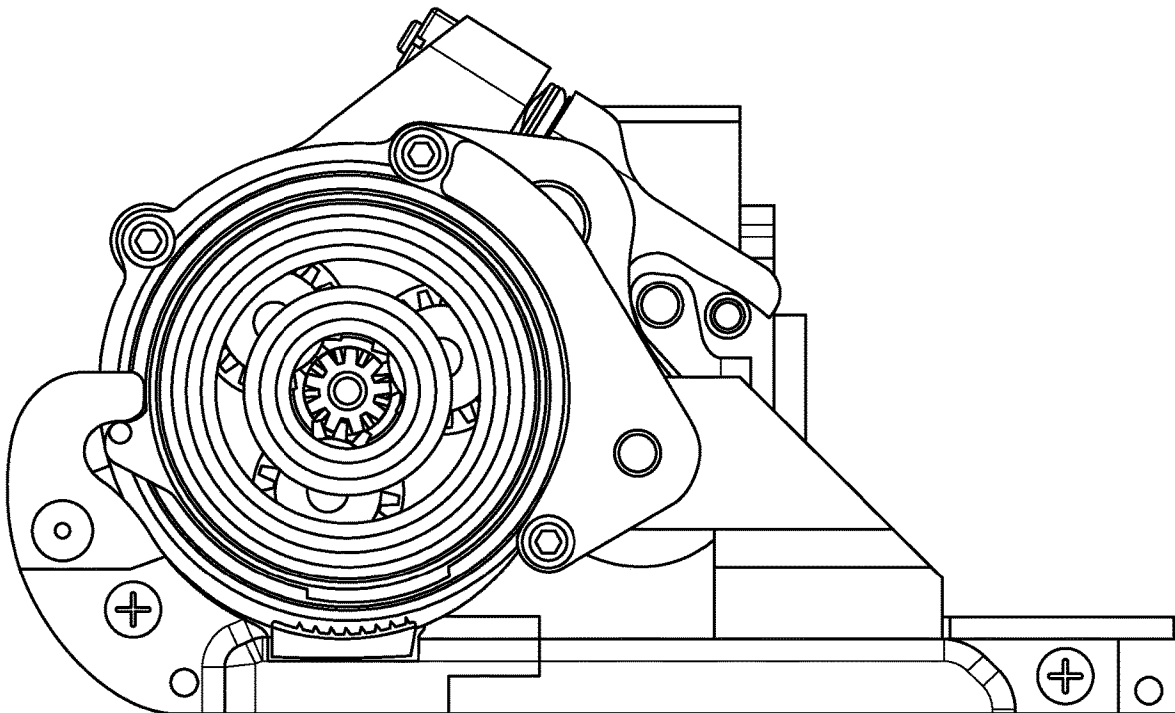


FIG. 11

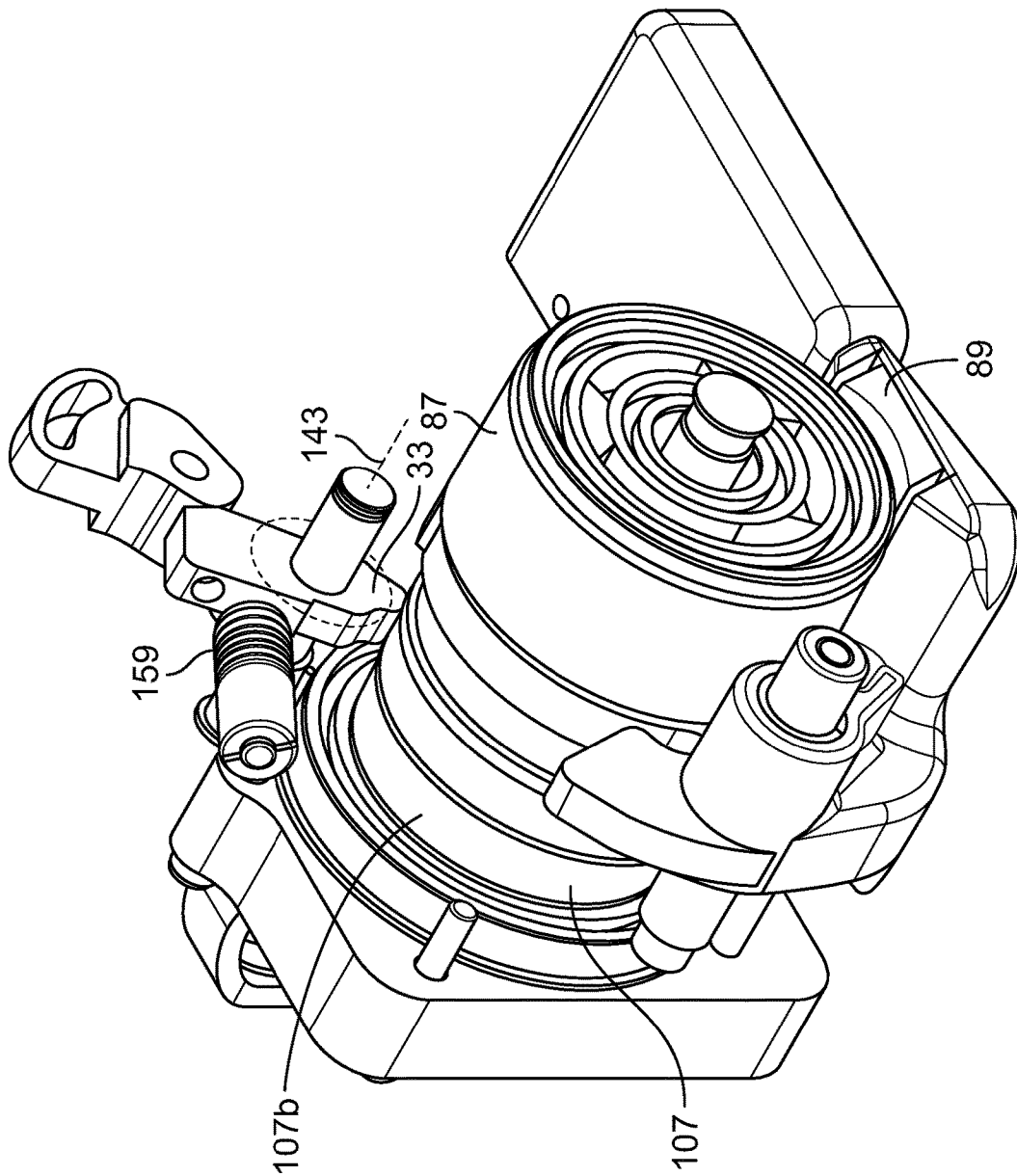


FIG. 12

U.S. Patent

Jun. 6, 2023

Sheet 9 of 10

US 11,667,417 B2

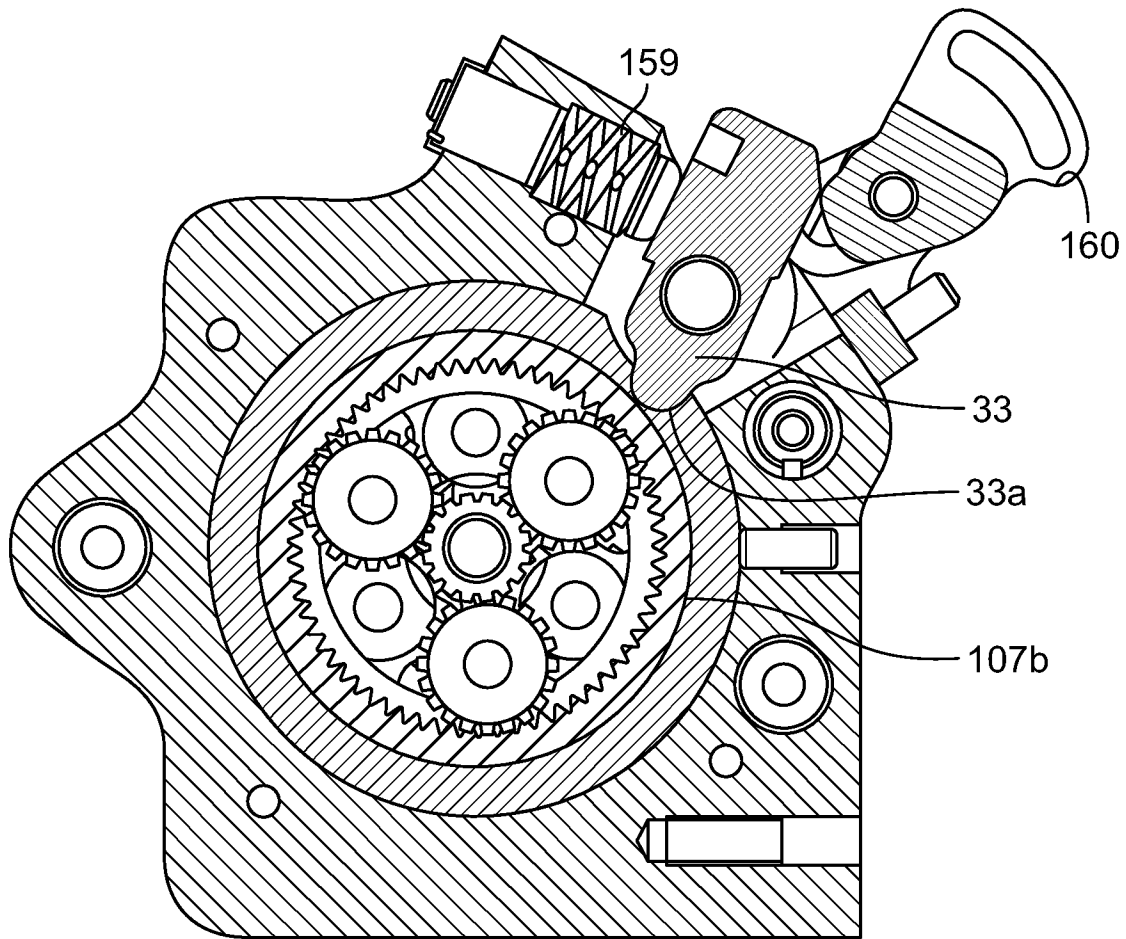


FIG. 13

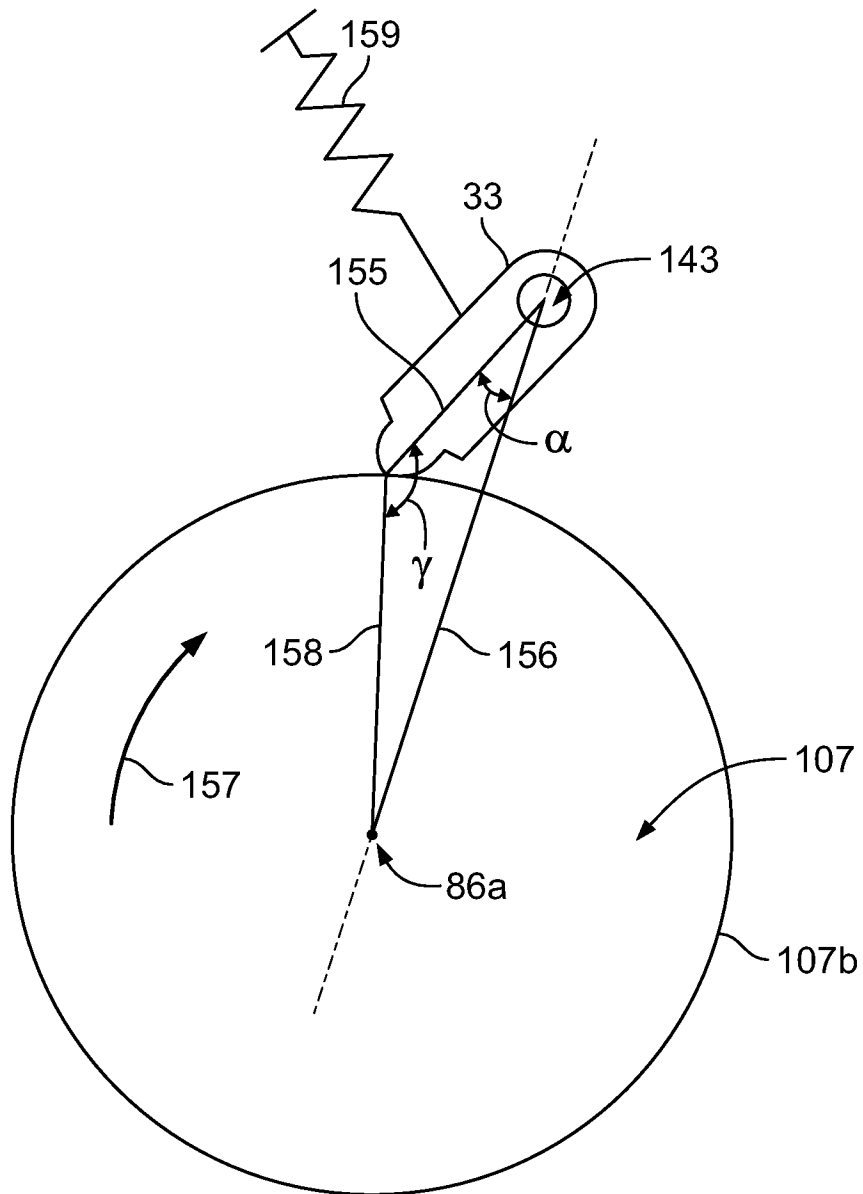


FIG. 14

US 11,667,417 B2

1

**STRAPPING DEVICE HAVING A
PIVOTABLE ROCKER****PRIORITY CLAIM**

This application is a continuation application of, claims priority to and the benefit of U.S. patent application Ser. No. 17/653,581, filed on Mar. 4, 2022, now U.S. Pat. No. 11,560,245, granted on Jan. 24, 2023, which is a continuation application of, claims priority to and the benefit of U.S. patent application Ser. No. 16/448,167, filed on Jun. 21, 2019, now U.S. Pat. No. 11,267,596, granted on Mar. 8, 2022, which is a continuation application of, claims priority to and the benefit of U.S. patent application Ser. No. 15/910,346, filed on Mar. 2, 2018, now U.S. Pat. No. 10,370,132, granted on Jul. 17, 2019, which is a divisional application of, claims priority to and the benefit of U.S. patent application Ser. No. 14/430,163, filed on Mar. 20, 2015 as a 371(c) Application of PCT/IB2013/002116, filed on Sep. 24, 2013, now U.S. Pat. No. 9,938,029, granted Apr. 10, 2018, which claims priority to and the benefit of Switzerland Patent Application No. 1723/12, filed on Sep. 24, 2012, and Switzerland Patent Application No. 1724/12, filed on Sep. 24, 2012, the entire contents of each of which are incorporated herein by reference.

The present disclosure concerns a strapping device, such as a mobile strapping device, for strapping packaged goods by way of a strap, which has a tensioning apparatus for applying a strap tension to a loop of a strap, wherein the tensioning apparatus is provided with a tensioning wheel which can be rotationally driven about a tensioning axis in a motorized manner, being configured to engage with the strap, the tensioning apparatus furthermore having a tensioning plate, wherein it is provided during a strapping process performed by the tensioning apparatus that a one or two-ply segment of strap is located between the tensioning wheel and the tensioning plate and makes contact with both the tensioning wheel and the tensioning plate, and moreover the tensioning wheel and/or the tensioning plate is arranged on a rocker which can pivot in a motorized manner about a rocker axis in order to either increase or decrease a distance between the tensioning wheel and the tensioning plate by way of a pivoting motion, as well as a connecting device to produce a permanent connection, especially a welded connection, at two superimposed regions of the loop of strap by way of a connecting element, such as a welded element, which is provided for the local heating of the strap

Such strapping devices are used for the strapping of packaged goods by way of a plastic strap. For this, a loop of the particular plastic strap is placed about the packaged goods. As a rule, the plastic strap is pulled off from a supply roll. After the loop has been placed completely about the packaged goods, the end region of the strap overlaps with a segment of the loop of strap. The strapping device is now placed at this two-ply region of the strap, the strap being clamped in the strapping device, a strap tension is applied to the loop of strap by way of the tensioning apparatus, and a closure is produced between the two layers of strap by frictional welding on the loop. In this process, pressure is applied to the strap with a frictional shoe oscillating in the region of the two ends of the loop of strap. The pressure and the heat created by the motion melt the generally plastic strap locally within a short time. This produces a lasting connection between the two layers of strap, one which can only be loosened with great force. After this, or roughly at the same time, the loop is separated from the supply roll. The particular packaged goods have now been strapped.

2

Such strapping devices are intended for mobile use, during which the device is taken by the user to the particular place of use, where one should not be dependent on the use of energy supplied from the outside. The energy required for the intended use of such strapping devices in order to tension a strap about any given packaged goods and produce a closure is generally provided by an electric storage battery or by pressurized air in the case of known strapping devices. This energy produces the strap tension applied by way of the tensioning apparatus to the strap and a closure on the strap. Furthermore, such strapping devices are configured to join together only weldable plastic straps.

For mobile devices, a low weight is of special importance, in order to physically burden the user of the strapping device as little as possible when using the device. Likewise, for ergonomic reasons, the weight should be distributed as uniformly as possible over the entire strapping device, especially in order to avoid a concentration of weight in the head region of the strapping device. Such a concentration results in difficult handling of the device. Furthermore, the most ergonomical and user-friendly handling of the strapping device is always desired. In particular, the possibility of wrong operation and malfunction should be kept as low as possible.

In strapping devices of this kind, moreover, it should be ensured as a further aspect of functional safety that even after achieving rather high strap tensions little or no slip occurs between the tensioning wheel and the strap. Slip, on the one hand, can prevent the achieving of the possible strap tension values. But slip can also cause a longer time for the tensioning process and thus the overall strapping process. Moreover, due to the longer time of use of the particular strapping device per strapping operation and thus also the amount of energy needed per strapping operation, slip can also reduce the number of strapping operations for a single charge of the storage battery. Finally, slip also means that the desired strap tension value might not be achieved and thus the strap is not sufficiently taut, which can constitute a safety risk. In order to avoid slip as much as possible or at least reduce it, the tensioning wheel is usually provided with teeth and pressed by a force against the tensioning plate. The pressing force for this in known solutions can result from a spring by which the rocker with the tensioning wheel arranged on it is pressed against the strap and the tensioning plate located underneath. However, these solutions cannot be satisfactory, especially when higher strap tensions need to be generated, since (as has been discovered) slip cannot be sufficiently reliably prevented in this way during the tensioning process.

Therefore, the problem which the present disclosure is supposed to solve is to create a mobile strapping device of the mentioned kind with high functional safety, in which the intended strap tensions can be applied to the strap in a save manner with as little slip as is possible.

This problem is solved by the present disclosure in a strapping device of the mentioned kind in that during the transmission of the motorized driving motion to the tensioning wheel, preferably for as long as the tensioning wheel is engaging with the strap, by way of at least one transmitting device of the strapping device, a driving motion is transmitted to the rocker, which can be pivoted at least sometime during the course of the tensioning process, wherein the driving motion is intended to apply a torque to the rocker. According to the present disclosure, the torque applied to the rocker can be used to increase the pressing force of the tensioning apparatus against the strap. In one simple-design solution, the torque exerted on the rocker by transmitting

US 11,667,417 B2

3

device can come from a motor, whose driving moment increases the pressing force of the rocker against the strap in the course of the tensioning process. It is preferable for the motorized increasing of torque to occur especially during or after an increasing of the strap tension

Advantageously, a motor is used for the generating of the motorized torque for the rocker that also performs other driving motions. Especially favorably, one utilizes the motor and its driving motion with which the tensioning wheel is also driven. On the one hand, this can make an additional motor unnecessary, while still performing the function according to the present disclosure. On the other hand, the motor torque which usually also increases with increasing strap tension can be utilized to increase the pressing force. This enables an especially simple design for variable pressing of the rocker against the strap, independent of the tension. The latter can be done proportionately to the particular existing strap tension.

According to another aspect of the present disclosure, which is also of independent significance, a torque can also be applied to the rocker and transmitted that is based on a force exerted on the tensioning apparatus by the strap at a point of engagement of the strap with the tensioning apparatus. This force, which is a reaction of the tensioning force applied by the driven tensioning wheel to the strap, can be tapped from a suitable place and be transmitted to the rocker by transmitting device. For the least possible structural expense, the strap tension force at the tensioning wheel itself which is acting on the tensioning wheel can also be utilized. In particular, this can be used as torque acting on the tensioning wheel at any given time, which is taken from the tensioning wheel to the transmitting device of the tensioning apparatus and transmitted by them to the rocker.

Thus, according to the present disclosure, it is provided in advantageous fashion that the motorized driving movement for the tensioning apparatus is also used at least indirectly as a reaction, making use of the rotational movement driven by the motor of the tensioning wheel as well as a pivoting capability of the rocker during the tensioning process, to transfer a torque tapped by the tensioning wheel in engagement with the strap by way of the transmitting device to the rocker in order to increase a pressing force of the tensioning apparatus against the strap.

In one embodiment of the present disclosure, a gearing of the tensioning apparatus by which a motorized driving movement for the tensioning wheel can be stepped up or down, can be part of or the entire transmitting device with which the force acting on the tensioning wheel and resulting from the strap tension is transmitted from the strap to the rocker.

According to another aspect, the present disclosure can also be seen in that devices are provided for the variable pressing of the tensioning wheel or the tensioning plate against the strap, depending on the strap tension. Thus, the present disclosure calls for a variable pressing of the tensioning apparatus against the strap, depending on the strap tension.

In especially advantageous embodiments of the present disclosure, the strap tension created by the tensioning process is thus used advantageously to increase as well the pressing force of the tensioning wheel and/or the tensioning plate on the strap as the strap tension increases steadily, thereby working against the constantly increasing danger, as the strap tension likewise increases, of a "slip-through" or slippage of the tensioning wheel during the tensioning process. Thus, as the strap tension increases, so too does the pressing force of the tensioning wheel against the strap and

4

the tensioning plate. The present disclosure in such embodiments thus makes it possible to exert a high pressing force on the strap when the strap tension is already high and thus the danger of slippage between the tensioning wheel and the strap is likewise especially high if it is attempted to further increase the strap tension. Thanks to the likewise increasing pressing force in automated manner, i.e., without manual intervention, one can counteract the increasing danger of slippage and thus ensure the functional safety as well as a rapid strapping process even with high strap tension. Since the reaction of the strap to the action, namely, the strap tension introduced, as well as transmitting devices are used for this, which are derived from the tensioning apparatus, especially the tensioning wheel, and transmitted to the rocker, no intervention by the user is needed to achieve the action of the present disclosure, which is advantageously accomplished automatically in the strapping device.

In one embodiment of the present disclosure, the transmitting device, which advantageously constitute an operative connection between the tensioning wheel and the rocker, comprise a pivoting mounting of the rocker at least during the tensioning process and a rotary or rotationally mounted gearing element, which stands in an operative connection with the tensioning wheel during the tensioning process. The force of reaction of the strap is utilized as a torque and transferred to the rotary or rotational gearing element, such as a planet carrier of a planetary gearing. The rotary or rotational gearing element should be propped against a support element to resist the turning or rotating movement. The force of reaction of the tensioning wheel can then be transferred to the rocker through or by virtue of the support, so that an additional torque will act on the rocker, which can be utilized to increase the pressing force of the rocker against the strap. The transmitting device can advantageously be part of or the entire tensioning gearing by which a motorized driving movement or one coming from another energy supply source is directed with suitable rotational speed toward the tensioning wheel.

In an embodiment of the present disclosure, which also has independent significance, motorized driving movements can be utilized with identical directions of rotation of the only one motor not only to drive the tensioning wheel during the tensioning of the strap but also for a lifting of the rocker. In addition to this, the same driving movement can also be used for the variable pressing of the tensioning wheel against the strap being tensioned, in dependence on the strap tension. The dependency is organized in this case such that, with increasing strap tension, the pressing force exerted by the tensioning wheel on the strap also increases. Since with increasing strap tension the danger also increases of a slippage occurring between the tensioning wheel and the strap, one can counteract the danger of slippage by providing an increasing pressing force. In this embodiment the same direction of turning of the motor as for the tensioning is used. The motorized driving movement during the tensioning of the strap can be utilized such that, during the tensioning process of the strap by way of the tensioning wheel engaging with the strap and rotating against a strap tension, a counterforce acting from the strap to the tensioning wheel is utilized to increase the pressing force of the tensioning wheel in the direction of the tensioning plate.

According to another aspect of the present disclosure, it should be made possible with little design expense and easy operating capacity to maintain and release a force resulting from the strap tension and operating reactively on a gearing in order to transfer a driving movement to the tensioning wheel. The present disclosure thus concerns a locking device

US 11,667,417 B2

5

for use in a strapping device, with which a rotatable wheel can be clamped, which is provided for transmission of a driving movement, especially a gearing wheel of a tensioning apparatus of the strapping device. The locking device according to the present disclosure should have at least one clamping body which can pivot about an axis and is arranged at a distance from the wheel, which can be pivoted from a release position into a locking position in which it bears—by a portion of an arc-shaped contact surface—against an essentially planar peripheral clamping surface of the wheel, i.e., one which is free of form-fitting elements, wherein the clamping body has a pivot radius which is greater than a distance from the pivot axis of the clamping body to the peripheral clamping surface of the wheel, and the rotating of the clamping body about the pivot axis during the movement from the release position to a clamping position occurs in the opposite direction of turning to that of the wheel being clamped.

With such a locking device, one can accomplish very functionally secure locking of rotating gear wheels in a simple designed manner. The locking in the direction of turning of the wheel can be maintained with little force expenditure. The clamping force of the clamping body even increases automatically if one should try to turn the wheel further by increasing the torque.

The locking mechanism according to the present disclosure can be used with advantage especially for the releasable locking of a wheel of a gearing which belongs to a gearing by which a driving movement is supposed to be transmitted to a tensioning wheel of the tensioning apparatus of a strapping device. In this context, it can be provided especially for the clamping of a wheel of a planetary gearing by which the driving movement is to be transmitted to the tensioning wheel. With or at least assisted by a clamping of the wheel being clamped, one can define one of at least two takeoff directions of the gearing, in particular a takeoff direction of the gearing toward the tensioning wheel, so that the strap can be tensioned.

Moreover, it can be advantageous with a loosening of the clamping to also remove at least partly, or entirely, the strap tension acting on the tensioning wheel and the gearing. Since with such locking mechanisms relatively low release forces are needed to remove the clamping, even for high strap tension values, the present disclosure produces especially functionally safe and easy to operate strapping devices. The low operating and activating forces make it possible to do without a rocker handle, with which large torques have been produced heretofore in known strapping devices for lifting the rocker from the taut strap. Instead of a long rocker handle, one can now use a button or switch with which the tension releasing process occurs.

Other embodiments of the present disclosure will emerge from the claims, the specification, and the drawing.

The present disclosure shall be explained more closely with the help of sample embodiments represented schematically in the figures. There are shown:

FIG. 1 a strapping device according to the present disclosure in a perspective representation;

FIG. 2 an exploded representation of the tensioning apparatus of the strapping device from FIG. 1 with the motor;

FIG. 3 a perspective representation of the tensioning and closure mechanism of the strapping device from FIG. 1;

FIG. 4 another perspective representation of the tensioning and closure mechanism of the strapping device from FIG. 1;

6

FIG. 5 an exploded representation of another sample embodiment of the tensioning apparatus of the strapping device from FIG. 1 together with the motor;

FIG. 6 a perspective representation of the tensioning and closure mechanism of the strapping device from FIG. 1;

FIG. 7 another perspective representation of the tensioning and closure mechanism of the strapping device from FIG. 1;

FIG. 8 a side view of the tensioning apparatus from FIG. 5, in which a rocker is located in a first pivot end position;

FIG. 9 a side view of the tensioning apparatus of FIG. 5, in which the rocker is located in a second pivot end position;

FIG. 10 a side view of the tensioning apparatus of FIG. 2, in which the rocker is located in a position with large pressing force against a tensioning plate;

FIG. 11 a side view of the tensioning apparatus of FIG. 2, in which the rocker is located in a position with less pressing force against a tensioning plate as compared to FIG. 10;

FIG. 12 a partial perspective representation of the tensioning and closure mechanism;

FIG. 13 a sectional representation of the tensioning and closure mechanism;

FIG. 14 a schematic diagram of the geometrical relations of a strapping device.

The strapping device 1 shown in FIGS. 1 and 2, being exclusively manually operated, has a housing 2, which encloses the mechanism of the strapping device and on which a handle 3 is fashioned for handling the device. The strapping device, moreover, is provided with a base plate 4, whose bottom side is provided for being placed on an object being packaged. All the functional units of the strapping device 1 are fastened to the base plate 4 and to the carrier connected to the base plate, not otherwise depicted.

With the strapping device 1, one can tension a loop of plastic strap B, not otherwise shown in FIG. 1, for example, one made of polypropylene (PP) or polyester (PET), which has previously been placed around the object being packaged, by way of a tensioning apparatus 6 of the strapping device. For this, the tensioning apparatus has a tensioning wheel 7, with which the strap B can be grasped for a tensioning process. The tensioning wheel 7 is arranged on a pivoting rocker 8, which can swivel about a rocker pivot axis 8a. The tensioning wheel 7, arranged with its axis of rotation at a distance from the rocker pivot axis 8a, can be moved by a pivoting motion of the rocker 8 about the rocker pivot axis 8a from one end position with a distance from a curved tensioning plate 9 arranged on the base plate 4 to a second end position in which the tensioning wheel 7 is pressed against the tensioning plate 9. By a corresponding motor-driven movement in the reverse direction of rotation about the rocker pivot axis 8a, the tensioning wheel 7 can be removed from the tensioning plate 9 and swiveled back to its starting position, such that the strap located between the tensioning wheel 7 and the tensioning plate 9 is released for removal.

During use of the indicated embodiment of tensioning device, two layers of the strap are situated between the tensioning wheel 7 and the tensioning plate and are pressed by the tensioning wheel 7 against the tensioning plate. By rotation of the tensioning wheel 7, it is then possible to provide a sufficiently large strap tension to the strap loop for packaging purposes. The tensioning process and the tensioning device and rocker 8 advantageously designed for this shall be explained more closely below.

After this, a welding of the two layers can be done in familiar fashion at a location of the strap where the two layers of the strap loop are superimposed on each other, by

US 11,667,417 B2

7

way of the friction welding device **12** of the strapping device. In this way, the strap loop can be permanently closed. In the sample embodiment shown here, the friction welding and separating mechanism **12** is actuated by the same only one motor **M** of the strapping device with which all other motor-driven movements are also performed. For this, in familiar manner, there is provided a not otherwise depicted freewheeling in the direction of transmission from the motor **M** to the places where the motorized driving movement occurs, which has the effect that the driving movement is transmitted in the particular desired rotary driving direction to the corresponding functional unit of the strapping device and no transmission occurs in the other particular rotary driving direction of the motor.

The friction welding device **12** for this is provided with a welding shoe **13**, shown only highly schematized, which is moved by way of a transmission mechanism **14** from a position of rest at a distance from the strap to a welding position in which the welding shoe is pressed against the strap. The welding shoe pressed by mechanical pressure against the strap in this way and the simultaneously occurring oscillating movement of the welding shoe with a predetermined frequency melts the two layers of the strap. The locally plasticized or melted regions of the strap **B** flow into one another and after a cooldown of the strap **B** there is produced a connection between the two strap layers. Insofar as is necessary, the strap loop can then be separated from the supply roll of strap by way of a cutting device of the strapping devices **1**, not otherwise depicted.

The infeed of the tensioning wheel **7** in the direction of the tensioning plate **9**, the rotary driving of the tensioning wheel **7** about the tensioning axis **6a**, the lifting of the tensioning wheel from the tensioning plate, the infeed of the friction welding device **12** by way of the transmission mechanism **14** of the friction welding device **12** as well as the use of the friction welding device **12** in itself and the activating of the cutting device occur by use of only a single common electric motor **M**, which provides each time a driving movement for these components of the strapping device. For the power supply of the motor **M**, a replaceable storage battery **15** is arranged on the strapping device, especially one which can be removed for recharging, which serves to store up electrical energy. A supply of other external auxiliary energy such as pressurized air or other electricity can be provided, but does not occur in the case of the strapping device per FIGS. **1** and **2**.

As shown in FIG. **4**, the strapping device according to the present disclosure provides for a tapping of the driving movement of the motor **M** at two places of its drive axis, either for the tensioning apparatus **6** or for the friction welding device **12**. For this, the motor **M** can be operated in either of the two rotary directions. The shifting of the transmission of the driving movement to the tensioning apparatus **6** or to the friction welding device **12** is done automatically by a freewheeling arranged on the drive shaft of the motor **M** (and not otherwise shown) in dependence on the rotary direction of the drive shaft of the motor. In one rotary direction of the drive shaft, the driving movement is transmitted to the tensioning apparatus **6**. Thanks to the freewheeling, the friction welding device **12** experiences no driving movement in this case. In the other rotary direction, the tensioning apparatus **6** has no driving movement and the friction welding device **12** is driven. No manual shifting is required in this embodiment for changing the direction of transmission of the motorized driving movement. Such freewheeling in connection with a strapping device is already known, and so it shall not be further discussed here.

8

As is likewise shown in FIG. **4**, the motorized transmission of the driving movement to the friction welding device **12** and transmission mechanism **14** occurs by any suitable manner. This might be, for example, a toothed belt drive with a toothed belt closed into a ring. One of the two gears is arranged on the drive shaft of the electric motor **M**, the other one belongs to a gearing of the friction welding device **12**, by which the motorized driving movement moves both the transmission mechanism **14** and the welding shoe **13** of the friction welding device **12**. In this way, the welding shoe pressed against two overlapping layers of the strap can be placed in an oscillatory movement with predetermined frequency and amplitude, by which the two strap layers are locally melted in the region of the welding shoe and welded together by the subsequent cool down.

On the drive shaft of the motor, situated behind the toothed belt drive for the welding mechanism as seen from the motor **M**, there is a bevel gear **19**, which belongs to a bevel gearing of the tensioning apparatus, as does a second bevel gear **20** meshing with it. On the same shaft where the second bevel gear **20** is arranged there is also located a first gear **21** of another toothed belt drive **22**, which is furthermore led across a second gear **23**. The first gear **21** of the toothed belt drive **22** is arranged on the shaft **24** firmly against rotation.

On the other end of the shaft **24** is mounted the rocker **8** of the strapping device, being part of the tensioning apparatus **6** and also carrying an upstream gearing from the tensioning wheel **7**, in the present case a planetary gearing **26**, for which suitable bearing sites can be provided on the rocker **8**. The rocker **8** is shoved onto the shaft **24** such that the rocker **8** is arranged and supported so that the rocker **8** can pivot about the longitudinal axis of the shaft **8**. The longitudinal axis of the shaft **24** is thus at the same time the rocker pivot axis **8a**, about which the rocker **8** can swivel.

The planetary gearing **26** can be configured as a single or multiple-stage planetary gearing, in particular, a two or three-stage planetary gearing. From an end face of the gear **23** facing the tensioning wheel **7**, there sticks out an externally toothed input sun gear **30** belonging to the planetary gearing **26**, whose axis of rotation is identical to the axis of rotation **6a** of the input gear **23**. On a shaft of the gear **23** on which the sun gear **30** is also configured in the sample embodiment, a freewheeling **45** is provided, which only enables one rotary direction of the sun gears **30**, namely, the rotary direction which is provided for the driving of the tensioning wheel. The sun gear **30** is led through a ring gear **27** and through a central recess of a planet carrier **25**, which are likewise part of the planetary gearing **26**. Looking from the input side of the planet gear, the planet carrier **25** is arranged behind the ring gear **27** on the axle of the planetary gearing **26** corresponding to the tensioning axis **6a**. The planet carrier could also be configured as a clamping, coupling or spur gear.

The ring gear **27** has at its outer circumference a cam **27c**, which engages with an abutment **46** secured to the base plate **4** of the strapping device. The internally toothed ring gear **27** is supported in this way so that the cam **27c** can execute slight relative movements within its engagement with the abutment **46**, for example, in a recess **46a** of the abutment. Furthermore, the ring gear **27** has a ring-shaped shoulder **27a**, on which a roller bearing **28** is arranged for the mounting of the planetary gearing **26**.

The planet carrier **25**, whose axis is aligned with the tensioning axis **6a**, engages by its three planet gears **25b** with an internal toothing of the input ring gear **27** of the planetary gearing **26**. The planet gears **25b** of the planet

US 11,667,417 B2

9

carrier 25 furthermore engage with the sun gear 30, from which they can obtain a driving movement and transmit it, appropriately stepped down, to the ring gear 27. Thus, given a rotationally fixed arrangement of the planet carrier 25, a rotational movement of the sun gear 30 can be converted into a rotational movement of the ring gear 27. In the sample embodiment, a first clamp 29 of a locking mechanism is configured as a pivoting cam, which can be brought into contact with a clamping surface 25a on the outer circumference of the planet carrier 25 or pivoted away from the clamping surface 25a with a spacing. The cam is arranged so that, upon contact of the cam with the clamping surface 25a by a rotation of the input planet carrier 25 in the rotary direction provided for the planet carrier 25, the clamping action is further intensified. By an infeeding of the cam onto the clamping surface 25a by a corresponding shifting movement, the planet carrier 25 can be blocked against rotation. By another shifting movement, the cam 29 can be moved away from the clamping surface 25a, thereby releasing the planet carrier 25 for rotational movements. The shifting movement can trigger a pivoting motion of the clamp 29 about a shift axis 143, which is produced by activating a button 44.

The sun gear 30 is furthermore arranged in the region of the axis of rotation 31 of a ring gear 32, whose nontoothed external surface 32a is coordinated with a second clamp 33. The axis of rotation 31 is identical to or aligned with the tensioning axis 6a. The clamp 33 interacting with the outer surface 32a can essentially be configured in the same way as the first clamp 29 as a shifting cam, which can move between two end positions, whereby in the one position the ring gear 32 is blocked against rotation and in the other position the ring gear 32 is released for rotational movements. Moreover, an internal toothing of the ring gear 32 engages with three planet gears 34, which are mounted at the end face of the following planet carrier 35, facing the ring gear 32. The planet gears 34 of the planet carrier 35 furthermore engage with the sun gear 30 of the input gear 23, which protrudes into the ring gear 32.

The locking device in the embodiment being described is configured so that always only one of the gears 25, 32 is clamped against rotation and the other gear 25, 32 is free for rotational movements. Thus, depending on the positions of the locking devices 29, 33, it is possible for a rotational movement of the gear 23 and the sun gear 30 to result in either a rotation of the planet carrier 35 about the tensioning axis 6a and axis of rotation 31 by virtue of a movement of the planet gears 34 in the internal toothing of the ring gear 32. Or the rotation of the sun gear 30 depending on the positions of the locking device results in a rotation of the ring gear 32. If the planet carrier 25 is not clamped by the locking mechanism, the rotating sun gear entrains the planet gears 25b so that the planet carrier 25 rotates and the ring gear 27 remains stationary. On the other hand, if the ring gear 32 is not clamped, a rotation of the sun gear 30 results in an entrainment of the planet gears 34, which in turn set the ring gear 32 in a rotational movement. Since the resistance to rotation in the further course of the planetary gearing 26 is greater toward the tensioning wheel 7 than the torque needing to be overcome in order to set the ring gear 32 in rotation, the ring gear 32 will primarily rotate in this case and the tensioning wheel 7 at least for the most part will not rotate.

At the other end face of the planet carrier 35, turned toward the tensioning wheel 7, there is arranged rotationally firm on the planet carrier 35 another sun gear 36, which meshes with planet gears 41 of another planet carrier 42. A

10

further sun gear 43 directed toward the tensioning wheel 7 and connected rotationally firm to the planet carrier 42 is led through a recess of the additional planet carrier 37, configured as a ring gear. The sun gear 43 stands in meshing engagement with planet gears 38 of the additional planet carrier 37, facing the tensioning wheel 7. The planet gears 38 of the second planet carrier 37 mesh in turn with an internal toothing of the tensioning wheel 7 and drive the latter in its rotational movement about the tensioning axis 6a. This rotational movement of the tensioning wheel 7, provided with a fine toothing on its external circumferential surface, is utilized to grasp the strap B with the circumferential surface and pull back the strap of the strap loop, thereby increasing a strap tension in the strap loop.

The third planet carrier 37 has a shoulder 37a on its outer surface, which can be brought into contact against a stop element 39 by a rotational movement. The stop element 39 itself is fixed not to the rocker, but to the base plate 4 or some other carrier, which does not participate in the pivoting motion of the rocker 8. Thus, the stop element 39 is stationary in regard to the shoulder 37a.

In use when strapping packaged goods, the strapping device 1 behaves as follows: after a loop of a customary plastic strap has been placed around the particular packaged goods, this is placed inside the strapping device in the region of the end of the strap where the strap loop is double-ply for a certain length, and the end of the strap is secured in the strapping device by a strap clamp, not otherwise depicted. A section of the strap B immediately next to the strap loop is placed in double layer on top of the tensioning plate 9 of the tensioning apparatus 6. The rocker 8 with the tensioning wheel 7 and the upstream gearing 26 is situated in its upper end position, in which the tensioning wheel 7 is arranged at a spacing (by its greatest design spacing) from the tensioning plate 9, so that the largest possible opening gap is produced, enabling an easy, comfortable and thus also rapid placement of the strap in the tensioning apparatus. After this, the rocker is lowered onto a tensioning plate 9 opposite the tensioning wheel 7 and pressed against the strap arranged between the tensioning plate 9 and the tensioning wheel 7. Both this transfer movement of the tensioning wheel and the magnitude of the pressing force exerted on the strap by the tensioning wheel at the start of the tensioning process can be produced in the described embodiment of the present disclosure by one or more prestressed spring elements 44 (not shown). By activating a button 10, the spring element can be released and the entire strapping process triggered with its consecutive steps of "tensioning", "closing", "cutting", releasing the tension of the strap in the region of the tensioning apparatus, and "lifting of the rocker", for which no further intervention by the user of the strapping device need occur.

After the tensioning wheel 7 is moved automatically from the open position to its tensioning position (see the tensioning position in FIG. 10 and the open position in FIG. 11), where the tensioning wheel 7 lies on the strap B and presses across the strap on the tensioning plate 9, the motorized driving movement is transmitted to the tensioning wheel 7. Now the second clamp 33 is moved into its position in which the second clamp 33 presses against the ring gear 32. The ring gear 32 is thereby arrested from rotational movements and locked. The first clamp 29, on the other hand, continues to be positioned at a spacing from the input planet carrier 25 and releases the ring gear 27 for rotational movements. The motorized driving movement, which thanks to the particular designated rotary direction of the motor M is transmitted via the bevel gearing 19, 20, 21 to the second toothed belt drive

US 11,667,417 B2

11

22 and thus to the gear 23, goes from here in the sequence of the following mentioned gearing elements via the input gear 23, the sun gear 30, the planet gears 34, the sun gear 36, the planet gears 41, the sun gear 43 and via the planet gears 38 to the tensioning wheel 7. The tensioning wheel 7 can be driven by the multistage planetary gearing in greatly stepped-down rotational movement of the motor—and thus when necessary with correspondingly high torque—in the predetermined rotary direction.

In the just described “tensioning” operating state of the strapping device, the driven tensioning wheel 7 in engagement with the strap produces a corresponding, oppositely directed counterforce on the tensioning wheel 7, depending on the resistance resulting from the strap tension and acting on the tensioning wheel 7. This counterforce acts in the reverse direction of transmission of the motorized driving movement on all gearing elements of the multistage planetary gearing that are involved in the transmission of the driving movement. If a different type of gearing from a single or multiple-stage planetary gearing is used, the counterforce resulting from the already applied strap tension and put into the respective gearing via the contact with the tensioning wheel is also available for use in accordance with the present disclosure. According to the present disclosure, this counterforce can be used to improve the conditions of the process, especially the functional safety even when the applied strap tension is high. Thus, in order to use this counterforce for the following described purpose, it would be possible in theory to use each of these gear elements for this, in particular, to pick off and employ the mentioned counterforce at each of these gear elements.

In the sample embodiment, the planet carrier 37 is used for this. The planet carrier 37 is buttressed in this case via the stop element 39 against the base plate 4, so that the entire tensioning apparatus 6 is pressed about the rocker axis 8a against the strap in proportion to the force of resistance (strap tension). The tensioning wheel 7 is thus pressed against the strap B proportionally to the strap tension. The strap tension generated by the tensioning process is utilized in advantageous manner to increase the pressing force of the tensioning wheel 7 on the strap B as the strap tension increases steadily, so that the danger of a “slip-through” or a slippage of the tensioning wheel 7 during the tensioning process, which also increases with increasing strap tension, can be counteracted.

For this, the planet carrier is configured with the engaging element 37a, which interacts with the stationary stop element 39. The engaging element, configured as a cam and arranged on the outer circumference of the planet carrier and projecting essentially radially from it, is buttressed against the stop element 39. As can be seen from FIG. 3, for this purpose the stationary stop element 39 is located in the region of the head end of the strapping devices. The stop element 39 in the sample embodiment shown is situated on one side, namely, the head end, of the tensioning axis 6a and the rocker pivot axis 8a running essentially parallel to it is on the other side of the tensioning axis 6a. The rocker 8, on which the planet carrier 37 is arranged via a roller bearing and able to rotate about the tensioning axis 6a, is also able to swivel at least during the tensioning process, i.e., it is not blocked against pivoting motions but instead released for these. Furthermore, the planet carrier 37 is able to rotate during the tensioning process about the tensioning axis 6a. The strap tension created in the strap B as a reaction to the tensioning process brings about a force on the tensioning wheel 7 which is opposite the rotary direction of the tensioning wheel provided during the tensioning process. This

12

reaction force acts from the tensioning wheel via the planet carrier 37 on the rocker 8 as a torque directed about the rocker pivot axis 8a, by which the planet carrier 37 is pressed with increased force against the strap in the direction of the tensioning plate 9. The higher the strap tension already produced in the strap, the higher the torque resulting from this and from the motorized driving movement continuing to act on the tensioning wheel 7. This torque, arising as a reaction, is in turn proportional to the resulting pressing force acting from the tensioning wheel 7 on the strap B, with which the strap B is pressed by the tensioning wheel 7 against the tensioning plate 9. Therefore, in the present disclosure, an increasing strap tension from the motorized driving movement on the tensioning wheel 7 goes hand in hand with an increasing pressing force of the tensioning apparatus on the strap.

After the ending of the tensioning process and the following welding process to form the closure and also after a motorized driven cutting process by a cutting device, not otherwise depicted, integrated in the strapping device, a quick and uncomplicated removal of the strap from the strapping device should be possible. To accomplish this, there is provided a motorized lifting movement of the tensioning wheel 7 from the clamping position. For this, the button is activated and for as long as the button 10 is activated the rocker also remains in the open position, in which a sufficient spacing is created between the tensioning plate 9 and the tensioning wheel 7. By releasing the button 10, the rocker is closed, for example, by spring force.

In the sample embodiment, to accomplish this at first the operative connection between the electric motor M and the tensioning wheel 7 is released and an operative connection is created between the electric motor M and the rocker 8. This is accomplished by switching the clamps 29, 33. The previously existing clamping of the ring gear 32 is lifted in that the second clamp 33 is removed from the outer surface 32a of the ring gear 32 and in this way the ring gear 32 is released for rotational movements. Basically at the same time or shortly thereafter, the first clamp 29 is lowered onto the clamping surface 25a of the planet carrier 25 and brought to bear against it in clamping fashion. In this way, the input planet carrier 25 is fixed and locked against a rotational movement about the tensioning axis 6a, along which the entire planetary gearing is situated.

In this way, the tensioning wheel 7 can turn freely without being driven and no longer has an operative connection to the electric motor M or the sun gear 30, such as might transmit a driving movement. A driving movement of the electric motor M with the same rotary direction as during the tensioning process is now utilized, thanks to the locking of the input planet carrier 25 of the planetary gearing, so that the planet gears 25b of the spur gear 25 entrain the input ring gear 27 in their rotational movement. The input ring gear 27 thus executes a rotational movement by virtue of the rotating planet gears 25b. The bearing and abutment of the ring gear 27 on the abutment element 46 leads to a pivoting motion of the ring gear 27 about the rocker axis 8a. The input ring gear 27, which is also connected rotationally firm to the rocker 8 thanks to the clamping, entrains the rocker 8 during this movement. This results in a lifting of the rocker 8 and the tensioning apparatus 6 secured to it, including the tensioning wheel 7. The rotational movement of the rocker 8 can be limited by an end stop or an end position sensor, which shuts off the motor M after reaching an end position in the opened position of the rocker 8 and triggers an arresting of the rocker. Thanks to the motorized lifting movement of the rocker 8 against the direction of action of the spring element

US 11,667,417 B2

13

44, the spring element 44 also is once more provided with a greater prestressing force. The strap B can now be removed from the strapping device 1.

The strapping device is now ready for a new strapping process, which can occur in the same way as the previously described strapping process. In order to lower the rocker 8 after introducing a new piece of strap B in the strapping device 1, the spring element 44 must be released again, which can be done for example via an operator button on the strapping device. In the sample embodiment, the previously actuated button 10 is released for this. The spring force then swivels the rocker, now in the opposite direction, against the tensioning plate and clamps the strap for the next tensioning process with an initial pressing force between the tensioning wheel 7 and the tensioning plate 9. The variable pressing force in the rest of the tensioning process increases in the manner described.

In FIGS. 5 to 9 is shown another sample embodiment of a strapping device according to the present disclosure. In regard to its external appearance, this can also correspond to the representation of FIG. 1. The basic layout of this embodiment of the strapping device can also correspond to that of the previously discussed embodiment of the present disclosure. Accordingly, in this embodiment as well, only a single motor M is used, which is provided to drive the welding mechanism 12 and separating mechanism (not shown in FIG. 5) in one of the two directions of rotation of the motor on the one hand and the tensioning apparatus 6 on the other hand in the other direction of rotation of the motor. The optional driving of either the welding mechanism and separating mechanism on the one hand or the tensioning apparatus 6 on the other hand is done via a freewheeling and different directions of rotation of the motor M.

The embodiment likewise shows a pivoting rocker 80 of the tensioning apparatus 86, driven by motor about a rocker pivot axis 80a. In contrast with the previously explained sample embodiment, here it is not the tensioning wheel 87 but instead the tensioning plate 89 which is arranged on the pivoting rocker 80, whose rocker pivot axis 80a runs parallel to the tensioning axis 86a. The motorized driving movement with the direction of rotation which is used for rotational movements about the tensioning axis 86a is also used in this sample embodiment for the pivoting motion of the rocker 80. The rocker pivot axis 80a in this embodiment as well runs essentially parallel to the tensioning axis 86a, about which the tensioning wheel can rotate. The rotational movement of the motor is transmitted, behind a point at which the motorized driving movement is utilized for the welding mechanism, across a bevel gear pair 99, 100 to a planetary gearing 106 and from this it goes further to the tensioning wheel 87. A freewheeling 125 arranged on the shaft of an input sun gear 110 ensures that the input side of the planetary gearing 106 can only turn in one rotary direction. The planetary gearing 106 is provided with gear elements which can be optionally arrested by way of a locking mechanism having two clamps 29, 33, as in the previously described sample embodiment, so that the driving movement can be transmitted either to the tensioning wheel 87 or to the rocker 80.

In order to open the tensioning apparatus 86, the ring gear 107 is released via the locking device, i.e., the clamp 33 is not in clamping engagement with the ring gear 107. The tensioning wheel 87 can in this way turn freely without an operative connection with the motor M. Optionally, strap tension still acting on the tensioning wheel 87 from the strap B from the previous tensioning process is released in this way by the tensioning wheel 87 and the gearing 106

14

upstream from the tensioning wheel. With the clamp 29, the spur gear configured as a planet carrier 105 is locked, and its axis of rotation is aligned with the tensioning axis 86a, i.e., the axis of rotation of the tensioning wheel 87. The motorized driving movement transmitted from the bevel gear 100 to the input sun gear 110, thanks to the removable rotary arresting of the planet carrier 105 performed by way of the clamp 29, does not lead to a rotation of the planet carriers 105 but instead to rotational movements of the planet gears 105b of the planet carrier 105. The internal toothing of the ring gear 109 which engages with these planet gears 105b places the latter in rotational movement. As is especially seen in FIG. 7, an external toothing 109c of the ring gear 109 engages with an external toothing 150c of a circular arc segment 150, which is disposed stationary on one end of a connection shaft 151. The connection axis 151a of the connection shaft 151 runs parallel to the stationary tensioning axis 86a of this sample embodiment. Instead of the two external toothings 109c, 150c, the ring gear 109 could also be braced by a cam against an abutment element, in which case either the cam or the abutment element is neither fastened to the ring gear 109 nor movable in design and the other of the two elements should be disposed on the ring gear 109.

The rotational movement of the ring gear 109 and the engagement of the ring gear 109 with the circular arc segment 150 results in a rotational movement of the connection shaft 151 about the connection axis 151a. A spur gear 152 arranged at the other end of the connection shaft 151 engages with an external toothing 117c of the planet carrier 117 and in this way transmits the rotational movement about the connection axis 151a to the planet carrier 117. In relation to the tensioning axis 86a, the connection axis 151a is situated on one side and the rocker pivot axis 80a on the other side of the tensioning axis 86a, the rocker pivot axis 80a being located on the side of the head end of the strapping device.

The planet carrier 117 belongs to the drive train provided for the driving movement of the tensioning wheel 87. The operative connection of this drive train to the motor M is momentarily broken thanks to the above described shifting process of the locking mechanism. Thus, at the above-described moment in the process there is no operative connection of the motor M with the tensioning wheel 87 to drive the latter. As a result of the rotary movement transmitted to the planet carrier 117, the planet carrier 117 rotates about the tensioning axis 86a and entrains a dog 80c of the rocker 80 by a cam 117a arranged on its outer circumferential surface. As a result, the rocker 80, appearing as an arc in plan view, is rotated and opened.

The rocker 80, able to turn about the rocker axis 80a and having the approximate shape of an arc segment, is arranged with its lower free end underneath the tensioning wheel 87, so that the tensioning plate 89 arranged in the region of the free end of the rocker 80 can likewise be arranged directly beneath the tensioning wheel 87. In order to arrange the tensioning plate 89 with a spacing from the tensioning wheel 87, the previously described motorized driven movement of the rocker 80 is used in the rotary direction along arrow 112 (FIG. 6), by which the rocker 80 is opened as described and a spacing between the tensioning wheel 87 and the tensioning plate 89 is increased. The opening movement can be limited by an end stop. The motor-opened rocker 80 now enables a removal of the tensioned and closed packaging strap from the strapping device. After the finished strapping is removed, the end of a new strapping loop for the next tensioning process can be introduced between the tensioning

US 11,667,417 B2

15

plate and the tensioning wheel. The rocker **80** can be brought back once again to the tensioning wheel by the restoring force of the spring element **124** previously stretched during the opening movement and press the strap against the tensioning wheel with an initial pressing force for the tensioning process. In order to utilize the spring force and thereby move the rocker **80** in a rotary direction along arrow **113** in the direction of the tensioning wheel **87**, an activation of a button or some other activating element can be provided, by which the spring force is released to act on the rocker. This can also involve a releasing of the button **10**.

In order to tension the strap **B** arranged between the tensioning wheel **87** and the tensioning plate **89**, the ring gear **107** is clamped on its outer circumferential surface by way of the clamp **33** to prevent rotational movements. The planet carrier **105** is not clamped, and so it can turn, as can the connection shaft **8**. The motorized driving movement from the sun gear **30** in the planetary gearing **106** arranged on the tensioning axis **86a** is transmitted through the planet carrier **105** and the ring gear **107** to the planet gears **114** of the second planet carrier **115** and sets the latter in rotation. A sun gear, not recognizable in the representation of FIG. **5**, drives the planet gears **121** of an additional downstream stage of the planetary gearing **106**. The planet carrier **122** of this stage also rotates. The sun gear **123** of the last-mentioned stage is further led through the additional planet carrier **117** and drives the planet gears **118** of this additional stage, which in turn are in engagement with an internal toothing of the tensioning wheel **87**. The tensioning wheel **87** is thus driven in the tensioning direction across the single or multiple-stage planetary gearing **106** and the inserted strap **B** is tensioned.

In the previously described operating mode of “tensioning”, in which the tensioning wheel **87** engages with the strap **B**, a force of resistance in the form of a restoring moment acting from the strap **B** on the rotating tensioning wheel **87** is produced by virtue of the strap tension. Its magnitude is variable and proportional to the magnitude of the applied strap tension. This force of resistance works opposite the motorized driving moment which arises in the gear elements participating in the transmission of the driving movement. In the sample embodiment, the planet carrier **117** is braced by a cam **117b**, having the function of an end stop, against the rocker **80**. The planet carrier **117** rotating by the motorized driving movement in a suitable rotary direction lies by its cam **117b** against a dog **80b** of the rocker and thereby turns it in a motion according to arrow **113** (FIG. **6**) about the rocker axis **80a** against the tensioning wheel. Optionally, a noticeable rotary movement about the rocker axis **80a** will not actually be executed here, but essentially only the torque about the rocker axis **80a** is increased. In either case, however, the pressing force by which the rocker **80** presses the tensioning plate **89** or the strap against the tensioning wheel **87** is increased. This increase generally does not occur in a single step. The increasing of the pressing force of the rocker against the strap, ultimately stemming from the motorized driving movement and the already existing strap tension and occurring by engaging with the tensioning gearing **106**, occurs proportionally to the resistance and restoring force present in the strap and acting as a resistance force against a maintaining and a further increasing of the strap tension at the point of engagement with the strap, from the strap to the tensioning plate **89** and on the tensioning wheel **87**. As long as an increasing of the strap tension is occurring by the tensioning process, so too will the resistance force increase and thus the pressing force resulting from it.

16

In FIGS. **8** and **9** are shown the end positions of the rocker **80** which are possible on account of the swiveling ability of the rocker to open and close on the one hand and to increased the pressing force on the strap on the other hand. As shown in FIG. **8**, in one of the two end positions the tensioning plate **89** by virtue of a contacting of the cam **117b** of the planet carrier **117** with a contour of the dog **80b** and a clockwise rotational direction of the planet carrier (in relation to the representation shown in FIG. **8**) rotates the rocker counterclockwise about its rocker pivot axis. The dog **80b** and the cam **117b** in this case act like a lever, which produces a counterclockwise torque about the rocker pivot axis **80a**.

FIG. **9** shows the end position of the opened rocker. Here, the planet carrier **117** turns in the opposite rotary direction as compared to FIG. **8** and thereby comes to bear against the dog **80c** of the rocker **80**. The dog **80c** is situated in regard to the rocker pivot axis **80a** and the other dog **80b** on the other side of the rocker pivot axis **80a**. In the position of use of the strapping device with a horizontal orientation of the base plate, the dog **80b** is situated above and the dog **80c** below the rocker pivot axis **80a**. In this way, the rocker swivels clockwise in the representation of FIG. **9** and thereby creates a spacing from the tensioning wheel **87**.

FIG. **12** shows a partial perspective view of the tensioning apparatus of the second sample embodiment, in which only one of the two clamps is depicted. Here, the clamp **33** is brought to bear against the flat circumferential surface **107b** of the ring gear **107**, which is essentially round in cross section. FIG. **13** shows a sectional representation through the ring gear **107** and the clamp **33**. By way of the clamp **33** of the locking mechanism, the ring gear can be optionally clamped against rotational movements or released again. Each of the clampings provided in the strapping devices of FIG. **2-11** can be configured according to the locking mechanism described here, however traditional locking mechanisms are also possible. In the clamping according to the present disclosure, an at least approximately planar circular or circular arc-shaped circumferential surface of the gear interacts with a pivoting clamping element or clamping body. The circumferential surface **107b** of the sample embodiment shown, functioning as a clamping surface, has no detent elements with which a clamping is provided that is based on a form-fitting engagement of a clamping element with a detent element or a detent recess.

The clamping element **33** is mounted so that it can pivot about the shifting and pivoting axis **143**, where the shifting axis **143** of the clamping element **33** runs parallel to the axis of rotation of the gear **107** being clamped. The shifting axis **143** runs in the region of one end of the camlike clamping element **33**. In the region of the other end of the clamping element there is provided an arc-shaped contact surface **33a**, which is provided for a contact with the clamping surface **107b** of the gear being clamped. Due to the circular shape of the clamping surface **109b** as well as the arc shape of the contact surface **33a** in side view, an essentially linear contact comes into being when the clamping element **33** contacts the circumferential surface **107b**, and this line of contact runs perpendicular to the plane of the drawing in FIG. **13**.

As emerges from FIG. **13**, the clamping element **33** is arranged in relation to the gear **107** being clamped such that the line of contact of the contact surface **33a** has a distance **155** from its pivot axis **143** which is greater than the distance of the pivot axis **143** from the clamping surface **107b**. As a result, during a pivoting motion of the clamping element **33** from its release position to a clamping position it already comes into contact with the clamping surface **107b** at a point which lies before a line of connection **156** of the axis of

US 11,667,417 B2

17

rotation of the gear **107** to the pivot axis **143** of the clamping element. In relation to the intended rotary direction **157** of the gear **107** being clamped, the line of contact occurs before the (imaginary) line of connection **156**. The rotation of the gear **107** is braked and can at most still move just a little. Thanks to a further rotation against the increasing clamping action, the clamping action is further intensified and an increasing wedging of the clamping element **33** against the gear **107** is intensified. Thanks to these geometrical relations, the clamp **33** cannot pass the line of connection **156** in rotary direction of the gear, its pivoting motion halts before the line of connection **156** and presses against the clamping surface **107b**. In an end position essentially corresponding already to the position of first contact with the clamping element **33**, the gear **107** is clamped against the camlike clamping element **33**. No further movement is possible, regardless of how high the torque is.

FIG. **14** shows the geometrical relations of the clamping. Here as well, the connection between the axis of rotation **86a** of the gear **107** and the pivot axis **143** is designated as **156**. The contact surface (circumference) of the gear could be smooth or structured. The radius of the gear at the contact site with the cam is designated as **158** and the pivot radius of the clamping element **33** at the contact site is **155**. The pivot radius **155** at the contact site subtends an angle α with the line of connection **156**, and the radius **158** of the gear **107** an angle γ with the swivel radius **155** (each time at the contact site). In the sample embodiment, the geometrical relations are such that in the clamping position, in which the gear **107** is blocked against rotational movements in the intended rotary direction, the angle γ is at least approximately 155° . In experiments it was also possible to achieve good results when using an angle from the range of 130° to 170° , especially from 148° to 163° . The angle α should advantageously be greater than or equal to 7° . In the sample embodiment, it is 9° . In other embodiments, it can also be chosen from a range of 7° to 40° .

In the sample embodiment of the present disclosure discussed here, it is not absolutely necessary, if the wedge effect is strong enough, to maintain the position of the cam in its clamping position by outside measures. This already occurs simply due to the fact that the gear **107** can only turn in one rotary direction and this is in fact blocked in removable fashion by the clamp **33**. In sample embodiments of the present disclosure, the camlike clamping element is held in position by the spring force of a spring element **159**. For this, the spring element **159** lies against the clamping element above the shifting axis **143** and turns or holds the clamping element **29** in its clamping position. In order to remove the clamping element from its clamping position, the spring force must be overcome with a switch **160**. Using the switch **160**, both clamps **29** and **33** can be activated at the same time. Depending on the arrangement of the switch/button, a pulling or pressing of the switch can overcome the spring force and release the ring gear **107** from the clamp **33** and lock the planet carrier **105**. In the other movement of the switch/button, the clamp **29** and the planet carrier **105** are again released via the spring force, while the clamp **33** locks the ring gear **107**.

List of reference symbols

1	strapping device
2	housing
3	handle
4	base plate

18

-continued

List of reference symbols

6	tensioning apparatus
6a	tensioning axis
7	tensioning wheel
8	rocker
8a	rocker pivot axis
9	tensioning plate
10	button
12	friction welding mechanism
13	welding shoe
14	transmitting mechanism
15	storage battery
19	bevel gear
20	bevel gear
21	gear
22	toothed belt drive
23	gear
24	shaft
25	planet carrier
25a	clamping surface
25b	planet gears
26	gearing
27	ring gear
27a	shoulder
27c	cam
28	roller bearing
29	first clamp
29a	arc-shaped contact surface
30	sun gear
31	axis of rotation of gearing and tensioning wheel
32	ring gear
32a	outer surface
33	second clamp
34	planet gear
35	planet carrier
36	sun gear
37	planet carrier
37a	shoulder
38	planet gear
39	stop element
40	arrow
41	planet gear
42	planet carrier
43	sun gear
44	spring element (restoring spring)
45	freewheeling
46	abutment
46a	recess
80	pivoting rocker
80a	rocker pivot axis
80b	dog
80c	dog
86	tensioning apparatus
86a	tensioning axis
87	tensioning wheel
89	tensioning plate
99	bevel gear
100	bevel gear
105	spur gear (planet carrier)
105b	planet gear
106	gearing
107	ring gear
107b	circumferential surface
109	ring gear
109b	circumferential surface
109c	external toothing
110	sun gear
112	arrow
113	arrow
114	planet gears
115	planet carrier
117	planet carrier
117b	toothings
117a	cam
117b	cam
117c	toothings
118	planet gear

US 11,667,417 B2

19

-continued

List of reference symbols

121	planet gear
122	planet carrier
123	sun gear
124	spring element
125	freewheeling
143	shifting axis
150	circular arc segment
150c	toothing
151	connection shaft
151a	connection axis
155	distance/swivel radius
156	connection line
157	rotary direction
158	radius
159	spring element
160	switch
B	strap
M	motor

The invention is claimed as follows:

1. A strapping device comprising:

a base comprising a tensioning plate;

a rocker pivotable about a rocker-pivot axis from a first rocker position to a second rocker position;

a tensioning wheel rotatable about a tensioning-wheel axis and pivotable with the rocker such that movement of the rocker from the first rocker position to the second rocker position moves the tensioning wheel away from the tensioning plate and movement of the rocker from the second rocker position to the first rocker position moves the tensioning wheel toward the tensioning plate;

a sealing device;

a spring imparting a spring force to the rocker that biases the rocker to the first rocker position; and

an input device movable from a release position to an activated position to activate a motor operably connected to the rocker to pivot the rocker from the first rocker position to the second rocker position, wherein the spring forces the rocker from the second rocker position toward the first rocker position responsive to the input device being released from the activated position.

2. The strapping device of claim 1, further comprising the motor.

3. The strapping device of claim 2, wherein the sealing device comprises a friction-welding device comprising a weld shoe, wherein the friction-welding device is movable between a release position and a welding position.

4. The strapping device of claim 3, wherein the motor is operably connected to the friction-welding device and configured to move the friction-welding device from the release position to the welding position.

5. The strapping device of claim 4, wherein the motor comprises a drive shaft operably connected to the rocker such that rotation of the drive shaft in a first rotational direction causes the rocker to pivot from the first rocker position to the second rocker position.

6. The strapping device of claim 5, wherein the drive shaft is operably connected to the friction-welding device such that rotation of the drive shaft in a second rotational direction opposite the first rotational direction causes the friction-welding device to move from the release position to the welding position.

7. The strapping device of claim 6, further comprising a transmission mechanism operably connecting the drive shaft

20

to the friction-welding device such that rotation of the drive shaft in the second rotational direction actuates the transmission mechanism to move the friction-welding device downward from the release position to the welding position.

8. The strapping device of claim 7, further comprising a lifting element operably connecting the drive shaft to the rocker such that rotation of the drive shaft in the first rotational direction causes the lifting element to move to impart a lifting force on the rocker to cause the rocker to pivot from the first rocker position to the second rocker position.

9. The strapping device of claim 8, wherein the lifting element is rotatable such that rotation of the drive shaft in the first rotational direction causes the lifting element to rotate to impart the lifting force on the rocker.

10. The strapping device of claim 9, wherein the lifting element comprises a ring gear.

11. The strapping device of claim 10, wherein the base comprises an abutment and the ring gear comprises an outer surface comprising a cam engaging the abutment.

12. The strapping device of claim 11, further comprising gearing operably connecting the drive shaft to the rocker, the gearing comprising the lifting element.

13. The strapping device of claim 12, further comprising one or more clamping elements movable from a first configuration to a second configuration to switch the gearing from a first state in which the gearing operably connects the drive shaft to the tensioning wheel so rotation of the drive shaft in the first rotational direction causes the tensioning wheel to rotate about the tensioning-wheel axis to a second state in which the gearing operably connects the drive shaft to the lifting element so rotation of the drive shaft in the first rotational direction causes the lifting element to rotate to impart the lifting force on the rocker and cause the rocker to pivot from the first rocker position to the second rocker position.

14. The strapping device of claim 13, wherein the one or more clamping elements prevent the ring gear from rotating when in the first configuration and do not prevent the ring gear from rotating when in the second configuration.

15. The strapping device of claim 8, wherein the lifting element is pivotable with the rocker.

16. The strapping device of claim 5, further comprising a lifting element operably connecting the drive shaft to the rocker such that rotation of the drive shaft in the first rotational direction causes the lifting element to move to impart a lifting force on the rocker to cause the rocker to pivot from the first rocker position to the second rocker position.

17. The strapping device of claim 4, wherein the motor is operably connected to the tensioning wheel and configured to rotate the tensioning wheel about the tensioning-wheel axis.

18. The strapping device of claim 17, wherein the motor is operably connected to the weld shoe and configured to oscillate the weld shoe.

19. A strapping device comprising:

a base comprising a tensioning plate;

a rocker pivotable about a rocker-pivot axis from a first rocker position to a second rocker position;

a tensioning wheel rotatable about a tensioning-wheel axis and pivotable with the rocker such that movement of the rocker from the first rocker position to the second rocker position moves the tensioning wheel away from the tensioning plate and movement of the rocker from

US 11,667,417 B2

21

the second rocker position to the first rocker position
moves the tensioning wheel toward the tensioning
plate;
a spring imparting a spring force to the rocker that biases
the rocker to the first rocker position; 5
an input device movable from a release position to an
activated position to activate a motor to rotate a drive
shaft operably connected to the rocker in a first rota-
tional direction to pivot the rocker from the first rocker
position to the second rocker position, wherein the 10
spring forces the rocker from the second rocker posi-
tion toward the first rocker position responsive to the
input device being released from the activated position;
and
a friction-welding device comprising a weld shoe mov- 15
able via rotation of the drive shaft in a second rotational
direction opposite the first rotational direction from a
release position downward to a welding position.

* * * * *

22